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THE ONTARIO WATER RESOURCES COMMISSION

REPORT OF THE

CONFERENCE

between the

PULP AND PAPER INDUSTRY

and the

ONTARIO WATER RESOURCES COMMISSION

at the

OWRC Laboratory Building

Toronto

November 14 and 15, 1961

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FIRST DAY

November 14, 1961

INTRODUCTORY REMARKS

by

A. M. Snider,
Chairman

Ontario Water Resources Commission

I wish to welcome such a distinguished group of visitors from the pulp and paper industry. This is a meeting to which we have looked forward for a long time, and today we have the fulfilment of our wishes. Members of the Commission are here to meet with representatives of the pulp and paper industry and to discuss with them the problems of the industry in respect to pollution.

We hope we will have your full co-operation in making this conference strictly informal. We are here to try to solve problems mutually, and to reach some conclusions which will be of mutual benefit.

Our Commission, of course, is a government commission. It tries to accomplish its purposes by persuasion rather than coercion. We want to co-operate with you in an earnest study of pollution problems with the hope we can solve these mutually. We are here to help you and from the response to our invitations to attend we know you are here with the same desire.

The Hon. Fred M. Cass, Q.C., Minister of Municipal Affairs, our new minister, unfortunately finds it impossible to be with us today, and has asked me to express his regrets and to extend his best wishes for the success of the conference.

It is now my privilege to introduce Hon. Paul Earl, Minister of Revenue of the Province of Quebec, the minister to whom the new Quebec Water Purification Board reports.

MR. EARL:-

Mr. Chairman and gentlemen--it is a pleasure for me to be here. I am a novice in the Quebec Board, but I have talked of water pollution for the last 12 years. Your problems are great in Ontario, but I believe our's are--well, it's difficult to say how much worse they are. The City of Montreal is completely surrounded by pollution. And, that is only one of many problems we have to take care of.

(Mr. Snider later introduced Dr. Gustave Prevost, Chairman of the Quebec Water Purification Board; Vice-Chairman A. L. VanLuven; W.C.R. Jones, vice president in charge of manufacturing, the E. B. Eddy Company, Hull. Que., and chairman of the Canadian Pulp and Paper Association's Executive Board Policy Committee on Stream Improvement; and Mr. Douglas Jones, executive secretary of the Technical Section of the Association.

(The OWRC chairman also introduced Hon. Charles S. MacNaughton, who had just resigned as a commissioner to become Minister Without Portfolio in the new Ontario government formed by the new Prime Minister, Hon. J. P. Robarts, Q.C., a former OWRC commissioner, and John Root, M.P.P. who had replaced Mr. MacNaughton on the commission.)

POLICY STATEMENT ON WASTE DISPOSAL

by

A. M. Snider
Chairman

Ontario Water Resources Commission

POLICY STATEMENT ON WASTE DISPOSAL

by

A. M. Snider
Chairman

Ontario Water Resources Commission

This conference provides the occasion for an intensive examination of means for combatting water pollution from the wastes of the pulp and paper industry. It is welcomed by the Ontario Water Resources Commission. In this co-operative atmosphere there should be an exchange of technical information and a review of our status in waste disposal, as well as a program for future action. This important meeting should also be the initiation of periodic conferences all aimed at seeking the most effective means of reaching our objective of clean streams for Ontario. This is intended to set the pattern for similar conferences with other groups of industry each having wastes of the same general kind.

At the outset of any conference it is prudent to examine our objectives and the means we hope to adopt to reach these. It is helpful for each group to outline its policy, how it looks on the program of the other, and how the two can be merged together to advantage. By a frank review of our thinking we should reach a basis for clear understanding. This will be our aim in these two papers on policy as viewed from two different angles.

OWRC LEGISLATION

The policy of the Commission must be related closely to the legislation under which it operates. Authority comes from the Legislature, and the administrative body is entrusted with the duty of putting that into effect. A review of some of the more directly related parts of the Ontario Water Resources Commission Act will provide a better understanding of the policy and the reasons for it.

The present Act was passed by the Ontario Legislature in 1957. It has been supplemented each year since by amendments. The administration is under a Commission rather than the usual Governmental Department. The function of the Commission is clearly set out; part of which is to control and regulate the use of water, to deal with sewage disposal, and to enforce generally a number of sections of this Act prescribing the protection for water quality. For carrying this out extensive

powers are granted, including the right under agreement with municipalities to build, finance and operate sewage works. A section dealing with the prohibition of the discharge of polluting material sets a penalty of up to $1000 for discharge into any waters or on the banks or shores thereof of any material which may impair the quality of the water. It is the duty of the Commission to direct the manner in which sewage and waste treatment facilities are to be operated. Additional powers are granted to the Commission through the right to pass regulations on a number of subjects. From the foregoing it will be clear that the Legislature was aiming at a high degree of protection and usefulness for the water resources of the province. The fact that the legislation received unanimous support of the Legislature adds force to the attitude of these representatives from all parts of the province.

THE RESPONSIBILITY OF THE COMMISSION

In administering the legislation now in effect the Commission has a two-fold obligation; one to see that the intention of the Legislature is carried out and particularly in regard to pollution control; the other to the people of Ontario who have the inherent right to expect clean streams and the maintenance of that water quality which will enable the widest use of these water resources. Basically these are the directives given to the Commission. It is for the Commission to carry these out in a manner which will be reasonable and expeditious. The details of this program are subject to review and modification from time to time.

WHAT IS POLLUTION TO-DAY?

It is necessary to have first of all a clear understanding of what constitutes pollution, especially in to-day's ever-changing conditions. It seems difficult for the layman to grasp this clearly. Some would go so far as to exclude everything which might change the quality of the water from that condition existing before population and industry were here. Others would be satisfied almost with anything, even bordering on an open sewer providing the wastes were carried away from their own doors. The legislation attempts to clarify this by prohibiting anything which may impair the quality of the water. It is to be assumed that this means impairment against reasonable uses. No one would expect to be able to take water from a stream in an inhabited area and use it for drinking purposes without first purifying it by some method. The important point is that the water quality does not deteriorate below a reasonable standard of purity.

Pollutants to-day include many kinds. We must not be concerned merely with those wastes of direct public health significance, great as that aspect may be, but our efforts must be against all forms of pollution which may interfere with the normal usefulness of our water resources. We are

now faced with many new kinds of pollutants, and more can be expected. These come from our industrial progress and our increasing high standard of living. They all spell advances in our environmental condition, but they bring with them many problems in waste disposal. It is for us all to find the answers to these. We must be conscious of anything which degrades water quality, and this can include such matters as silt from gravel washing operations, heat from power plants, oil wastes and others, none of which is of bacterial origin or is responsible for any specific disease.

Thus to-day we can be said to have entered a new phase of our forward march in pollution control. This is imperative as we grow in population and expand industrially. Water, which is always the same in volume, must under these circumstances be used more often before it escapes to the ocean. This principle of repeated use is now being recognized to a greater extent throughout the world, and particularly on this continent, than at any time in the past.

THE NEED FOR ACTION

With this situation facing us in Ontario the need for action is clear. We must not falter in the task assigned to us. The reward, in the form of clean streams, is a challenging one. We believe that if we face this challenge jointly and in a constructive manner we can be successful, and that municipalities and industries can carry on effectively and without undue financial burdens. It now seems desirable that we discuss some of the details of this program which forms the policy of the Water Resources Commission.

OWRC POLICY

In adopting a policy of clean streams for Ontario it is necessary to have a clear objective. The Commission early in its program, adopted "Water Quality Objectives". These were promulgated with two aims in mind, one to make certain that the streams would be protected, the other that these streams can carry away properly treated effluents, as any stream must do in a developed area. These water quality objectives are realistic rather than theoretical. They set up requirements which can be met, and which will result in water which can be made satisfactory for all normal uses. This must not be construed to mean that all waters can be used for drinking purposes without treatment, or that there will be no pollution present, but it does mean a standard of quality that will serve the needs of the people of this province successfully. This is our philosophy in stream sanitation for Ontario.

How do we expect to put this program into effect? Some of the features of this can be outlined here:

(a) The first of these is the fullest of co-operation with industry and all who face these pollution problems. The Commission desires to be of the utmost service to this industry and to all others. This will include technical assistance and a joint study of any problem. This is not a policeman's role, but rather that of a guide and mentor as might be expected from a public welfare agency.

(b) A second part of this concerns the degree of treatment of wastes. This will not be the same under all circumstances. The location of the outfall, and the volume of flow of water will influence the final result. If we are concerned primarily with the quality of the stream it is difficult to disregard these factors. A small stream can absorb much less organic matter than a large one. The Commission's policy is to require a sufficient degree of treatment to meet the local needs. While this may mean less cost to one industry than to another it will be obvious that many cost factors vary in manufacturing. Our problem is to deal with waste disposal and leave to industry the decision on costs. No municipality or industry is asked by the Commission to spend more on waste treatment than is necessary to meet the requirements of the receiving watercourse.

(c) Timing in waste treatment programs cannot be disregarded. Major programs, especially those of complex wastes, must of necessity be studied and planned carefully. This requires time. The work of construction can sometimes be carried out in stages. Circumstances will influence each case. The important factor, as far as the Commission can determine, is that waste disposal is a prime necessity to-day. Municipalities and industries are expected to proceed without undue delay.

The policy of the Commission is to require municipal and industrial action to proceed simultaneously. It cannot be expected that one will take care of its problem while the other continues to pollute the stream. The Commission is endeavoring to follow out this program as far as possible.

(d) The Commission's policy is to encourage the acceptance of industrial wastes into public sewers for treatment at a joint plant whenever it is feasible or advantageous. This is not likely to be the case with paper mill wastes, but there is a trend now to treat all wastes together with satisfactory financial arrangements between the two parties. Preliminary treatment of the industrial wastes is frequently necessary, but to ask industry to do more than this before discharge to the sewer is likely to be a duplication of efforts.

(e) The Commission believes that no new industry should start or modification of an existing process should take place without adequate provision for waste treatment. Thus the policy of the Commission is to stop further new pollution and to deal with existing pollutants as expeditiously as possible. Only in this way can we hope to achieve our objective.

(f) The policy of the Commission is to encourage in every way new, more efficient, and more economical methods of waste treatment, or to hope that processes may be so altered as to eliminate the difficult wastes. To this end all the facilities of our laboratory and technical staff are made available to industry. It is our intention to pursue this program aggressively and to work closely with the technical staff of industry. It is hoped that industry will feel free to discuss their problems with the Commission's staff and with the assurance that the information will be treated in confidence and used only for the purpose of finding an answer.

(g) Another link in the Commission's policy chain is the program of field surveys on streams and on all sources of pollution. This work is being carried out as rapidly as conditions permit. It is most valuable to industry in that it shows clearly what is the composition and nature of the waste as well as its likely effects on the watercourse. It is a distinct aid to the Commission in assessing water quality and in assisting in remedial measures. These surveys can be done either on each watershed or by municipal organization such as the county. Much of the work to date has been on the latter basis. It will be the continued policy of the Commission to repeat these surveys as often as conditions would seem to indicate In this work all modern methods of assessing quality will be used. The bio-assay of streams is one example of this.

(h) An important and fruitful development on the part of industry is organization within its own ranks to study and control pollution. The Commission, as part of its policy, is desirous of encouraging such activities. It reveals a fine public spirit and a recognition of industry's part in protecting the country's water resources. Much good has already come from these efforts and much more can be expected. The organization of and the work to date of the Effluent Improvement Committees are one of the best of these efforts. The grouping together of industry in an area, whether of the same kind or of different kinds, should be encouraged in every way.

(i) A related activity has been the industrial waste conferences under the direction of the Water and Pollution Advisory Committee to the OWRC. This has been a forum for industry to exchange information on procedures to follow. The Commission is pleased to aid in this in any way it can.

(j) The Commission has from its formation adopted the policy of co-operation with other agencies engaged in similar or related programs. The exchange of ideas and information can be of great assistance. This Commission welcomes wholeheartedly the creation of the New Brunswick Water Authority and the Quebec Water Purification Board. Our aim will always be to assist others, and to derive from them information which will assist in our efforts. Similarly we have initiated and intend to extend our discussions with agencies in the United States and elsewhere. All of this policy can be said to be aimed at gaining the maximum beneficial returns to the industries, municipalities, and the people of Ontario, and in return offering any services we can perform.

SUMMARY AND CONCLUSIONS

In summary it may be said that the Water Resources Commission has a clear policy in operation. It is, in brief, to prevent further pollution of our water resources by new industries or by new sewage works, and at the same time to attack existing pollution aggressively in a program aimed to ensure clean waters for this province, and the most beneficial use of these waters by all. Every effort will be made to assist in the solution of these pollution problems and the fullest co-operation can be assured.

POLICY STATEMENT

BY THE PULP AND PAPER INDUSTRY

by

W.C.R. Jones
Chairman

Canadian Pulp & Paper Association

Executive Board Policy Committee
on Stream Improvement

POLICY STATEMENT BY THE PULP AND PAPER INDUSTRY

by

W. C. R. Jones
Chairman

Canadian Pulp & Paper Association

Executive Board Policy Committee
on Stream Improvement

It is usual, when any sort of submission is being made, to establish competence and credibility of the person or group making the presentation. For this reason, I comment on the Committee for which I act.

The Canadian Pulp and Paper Association Executive Board Policy Committee on Stream Improvement is a group of executives who operate mills all across Canada. The members are not necessarily professional men able to go into the details of technical facts pertaining to the needs and the problems of stream improvement. All are, however, directly connected with operations which individually and collectively, through the Pulp and Paper Research Institute or the C.P.P.A. Technical Section, work continually on effluent improvement. The work has, is and will continue to be done for the reasons which one would expect in a great industry which has great responsibilities to owners, established customers and communities of employees. We know that as we improve the stream we cut the cost of treating water for our own use and cut the cost of our process by retention of fibre, chemicals and heat, all of which are increasingly expensive. We want very much to learn how to retain all on the mill property.

The members of the Committee are experienced executives with mills operating under the most varied geographic and climatic conditions. There are mills in remote areas where all of the water used must first be clarified because of muskeg discolouration. Even there, the dams needed must be given recognition as conservers of water and protection of spawning beds. Some members are associated with mills which are in the centre of what is usually called multiple-use streams where large cities use and discharge the water before or after many industries, including pulp and paper.

Still others use water from mountain streams, usually conserved by dams or forest areas of the industry, and sending the effluent to be infinitely diluted by the immediate presence of the ocean.

The Committee, like all the managers and technical people of our industry know that in this matter of stream improvement we deal with a problem with infinite variables. It is a problem which has been studied both from the point of view of supply and use since the industry came into being.

Many previous papers have been written and many will now be presented! Some sponsored by our active Regional Effulent Improvement groups.

Recently, Dr. Gustave Prevost, Chairman, Quebec Water Purification Board, presented one at the important "Resources for Tomorrow" Conference in Montreal. Last year, Mr. W. H. Palm, President of Hinde and Dauch, Toronto, spoke to the Ontario Conference on Co-ordinated Water Pollution Control. It would be hard to add significant statements on the problem generally or specifically, or as to our industries efforts, as both have been so well covered. Because of the excellence of these papers, however, I borrow from them:

Mr. Palm said, and this seems to sum up our feelings:

> "I think everyone would agree that the best solution to any problem is one which tends to provide an answer for the greatest number of inter-related problems and, coincidentally, poses the fewest additional problems. Applying this philosophy, therefore, to the reduction of water-borne waste, the industry must endeavour to find ways of converting waste products from the category of a <u>useless</u> to a <u>useful</u> material. To most people in the industry and others, this is a continuing effort being pressed relentlessly, not specially because it is a solution to waste disposal but as a means of improving the efficiency of our processes, of upgrading product yield from raw materials, of making more goods per unit of initial capacity, of making better use of labour and of providing more profit from the operation. This activity, of course, is not only proceeding among operating people but also by research and technical personnel in each company."

In his report on the Ottawa River Dr. Prevost said, and again one can only wholeheartedly agree:

> "But we must realize that, with the development of industry and population, it is practically impossible not to have waste in our streams. There is however a great difference between the present general practice of throwing everything in the river and the policy of retaining most of the waste by methods already known."

It is my personal opinion that the Pulp and Paper Industry has not done a good job of having all understand what effluent improvement there has already been - what process improvements have been made over the history of the industry by research done with tremendous attendant expenditures.

Nor have we sufficiently made the fact clear that as custodians of vast forest areas the industry is a supplier as well as a user of water. We have a vital interest in the flow of the river, both qualitative and quantitative! The retaining of growth conditions of moisture in the forest, the control of flow in the river and the retention of our paper making materials on the property, are all vitally important to us.

Since the turn of the century, the higher percentage yield from wood by the development of high yield pulps and the use of sawmill waste as chips has vastly reduced the fibrous materials going down the stream. Bark pressing and burning, now almost universal, is another great contribution.

Chemicals and heat waste from the chemical pulp mills are now a fraction of what they were 25 years ago, and this is in large measure the result of Canadian research. H. K. Moore and G. H. Tomlinson (1), and many more are names known throughout the world for ideas that have made these reductions possible.

The production of alcohol and vanillin are examples of use of chemical waste but, unfortunately, these products are not economic for all pulp mills using the sulphite process. Nor is it reasonable to expect rapid conversion of mills to the new processes being developed which make it possible even in the sulphite proccess to use waste liquor for heat and chemical regeneration.

The Research activities of our industry have been increased and these will result in even greater development of process. Canadian pulp and paper research is pressing hard on these problems of waste.

The supreme importance of the Canadian Pulp and Paper Industry to Canada's economy is so well known that a repetition of the facts is perhaps redundant. Perhaps the calling of this meeting is a recognition that the importance is understood. What is not so well known is that UNESCO says that the world's need of pulp and paper products in 1965 will be about 90 million tons and this will expand to 140 million tons in 1975.

Canada must be prepared to share in this growth. In sharing this growth, the industry will make more use of Canadian water resources and, as this water flows from these expanded mills, industrial waste will be conveyed with them. Fortunately, these expanded capacities will benefit by the improved pulping methods now in sight, better means for the retention of fibre and better flow sheets and equipment which will keep heat loss and water loss at a minimum.

However, this greater pulp and paper industry of the future will, as it is now, spread across one country, with each mill a separate problem.

The mill operating in a remote area with its many problems associated with this remoteness, must not be further hampered by unrealistic and unnecessary regulations. A mill in the centre of a multiple-use area must not be asked to do more than is expected of others, possible technically or necessary in the particular condition of the stream.

The studies of the effluents, which we in the industry have always done on almost an hourly basis, must be accompanied by concurrent study of the rivers and their own self-purification abilities.

Because of the complexities of this problem, the industry asks that any Provincial Regulations avoid the bludgeon of requests which cannot be met technically and economically.

The pulp and paper industry welcomes any effort that will make this most important raw material cleaner for its use and by its use. The industry recognizes its responsibilities and, because of this, is pleased to adopt as a matter of policy the following statements.

The Canadian Pulp and Paper Association recommends to all its member companies, active participation in Stream Improvement Committees.

It further recommends that there be full exchange of test and technical information by the industry with Effluent Improvement Committee groups and Government Water Regulation Boards.

It is agreed that emphasis be continued in the Technical Section of C.P.P.A., Pulp and Paper Research Institute of Canada and the Research Departments of the member companies to the end that the pulp and paper manufacturing industry will continue to reduce the economic loss of fibre, chemicals and heat which contribute to the problems associated with multiple-use of streams.

As Chairman of this industry committee I wish to express our appreciation of the invitation by the Ontario Water Resources Commission to take part in this important meeting.

ROLE OF THE CANADIAN PULP AND PAPER ASSOCIATION

by

Douglas Jones,
Executive Secretary

Canadian Pulp and Paper Association

ROLE OF THE CANADIAN PULP AND PAPER ASSOCIATION

by

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Canadian Pulp and Paper Association

I have been asked to introduce to the conference the role that the Canadian Pulp and Paper Association has been playing in coordinating the activities of individual pulp and paper companies in the field of waste reduction and effluent improvement. It has been said that Canadian industry which uses large quantities of water in processing, do not pay much attention to effluents and that no real concern was felt until the conservationists, by focusing public interest on the subject, forced us to take some action. This attitude is very far from the truth. Prior to 1940 the Technical Section, C.P.P.A. had an active committee known as the Waste Committee actively working in this field. This Committee later became the Chemical Engineering Committee and one of the major items in its terms of reference is the study of stream and effluent improvement conditions. Much money has been spent and much has been accomplished.

The Chemical Engineering Committee acts as the coordinating committee to keep the whole industry informed as to the newest methods of reducing fibre losses, studies of bark pressing and burning, and development of by-product production. Similarly other committees of the Technical Section, C.P.P.A., such as the Alkaline Pulping, Sulphite Pulping, Mechanical Pulping and the Fundamental Research Committees are studying continually, for the benefit of the whole industry, developments as they affect waste reduction and effluent improvement.

The Canadian industry has also maintained a very close liaison with the National Council for Stream Improvement in the United States. When the Ontario Water Resources Commission was first appointed various meetings were held with officials of the industry and of the Canadian Pulp and Paper Association. It was agreed at that time that the Commission would welcome contact with the industry through regional committees set up in the various watersheds. Accordingly, under the auspices of the Canadian Pulp and Paper Association the first of these committees was set up in April 1957. This was the Niagara Paper Mills Effluent Improvement Committee representing the seven mills in the area. Subsequently the Lakehead Paper Mills Effluent Improvement Committee representing the four lakehead mills was set up in June 1959 and in October 1959 we set up the Ottawa

Valley Paper Mills Effluent Improvement Committee. In order the following groups were appointed: February 1960 - the Saguenay - Lake St. John Pulp and Paper Mills Effluent Improvement Committee, in September 1960 - the Northwestern Ontario Kraft Mills Effluent Improvement Committee and in May 1961, - the St. Francis Valley Pulp and Paper Mills Effluent Improvement Committee.

Of the six committees now in operation three are in Ontario, two are in Quebec and one represents mills operating in both Ontario and Quebec.

Representatives of the pulp and paper industry have read papers at a number of the Industrial Waste Conferences held under the auspices of the Ontario Water Resources Commission. This conference programmed for today and tomorrow is the first conference to my knowledge held in Canada where the pulp and paper industry has been privileged to submit evidence of its efforts to a meeting with a provincial regulatory agency. We welcome this opportunity of presenting to you concrete evidence of the industry's acknowledgement of its responsibilities in the field of pollution control and abatement.

My role today is to introduce the next three reports which will be made by the three effluent improvement committees which have been operating in Ontario. I will not at this time outline the terms of reference of these committees as this will be done in the course of the presentations. These committees are management ones having in each case the mill manager of each mill, in a watershed, an active member of the committee.

As Mr. W.C.R.Jones has outlined to you earlier we now have another committee which will coordinate the efforts of all the regional committees and will speak for the industry on matters of policy in the effluent improvement field. I act as Secretary to this Policy Committee. I am sure that you will agree when you have heard the three reports to follow that the pulp and paper industry has not lagged behind in its endeavours to impliment action to reduce its losses in effluents. I can assure you that it will continue its studies and research and that eventually, based on sound biological principles that it will do everything that is economically possible to achieve the recommended objectives of the Ontario Water Resources Commission. We must all recognize however that if our industry is to maintain its competitive position in world markets we cannot afford to be priced out of the world market. We should be expected to play our part in effluent improvement but must in return ask that we do this in an enviroment that bases the result on sound biological principles taking full advantage of the fact that waterways must and should be used to assimilate some reasonable amounts of waste materials.

REPORTS OF

ONTARIO EFFLUENT MILLS IMPROVEMENT COMMITTEES

* * * * * *

A PROGRESS REPORT

by

NORTHWESTERN ONTARIO KRAFT MILLS EFFLUENT IMPROVEMENT COMMITTEE

presented by

Chairman R. G. Shirriff

November 14th, 1961.

NORTHWESTERN ONTARIO KRAFT MILLS
EFFLUENT IMPROVEMENT COMMITTEE

A PROGRESS REPORT

INTRODUCTION

1. Committee Formation

The Ontario Pulp and Paper industry recognizes that there is no simple solution to the water improvement problem in the province. Industry should strive to keep each waste receiving stream or body of water within its "waste assimilative capacity". In recognizing that every industry has a separate problem, requiring a separate approach, the Pulp and Paper industry has organized several groups, bringing together several mills in each district which have similar pulping operations, to attack the stream improvement problem in the area.

In order to assist the Ontario Water Resources Commission, by forming a group representing similar pulping operations rather than individual mill contact with the Ontario Water Resources Commission, representatives from the five Northwestern Ontario Kraft Pulp Mills met in Toronto, Ontario, on September 26, 1960, to form the Northwestern Ontario Kraft Mills Effluent Improvement Committee.

2. Participating Mills:

The five Northwestern Ontario Kraft Mills represented on this Committee are as follows:

St.Lawrence Corporation Limited	Red Rock
The K.V.P. Company Limited	Espanola
The Dryden Paper Company Limited	Dryden
Marathon Corporation of Canada Limited	Marathon
Kimberly-Clark Pulp and Paper Company Limited	Terrace Bay

3. Terms of Reference:

(a) To cooperate with the Ontario Water Resources Commission and with each other, in carrying out investigations and planning for the improvement of the water utilization and/or, industrial waste conditions in the Kraft Pulp and Paper Mills in Northwestern Ontario.

(b) To collect and present facts and statistics that will inform the public on Pulp and Paper manufacturing problems as they affect pollution loads.

(c) To keep informed on technical developments and arrange attendance at meetings of the Ontario Water Resources Commission, or other organizations where such matters are discussed.

(d) To consider recommendations to senior management on what might be done to improve conditions at individual mills.

4. Frequency of Meetings:

The Northwestern Ontario Kraft Mills Effluent Improvement Committee is meeting every four (4) months, with each participating mill acting as host in turn.

SUMMARY OF PROJECT ASSIGNMENTS DURING THE FIRST YEAR OF ACTIVITIES

November 1960 to June 1961.

In order to study problems which may be common to all mills represented on this Committee, and to afford group assistance to an individual participating mill by suggesting methods to control and improve stream conditions, it was first necessary to determine the present position of each mill with regard to stream improvement programs.

Programs that have been undertaken to reduce the loading of a mill effluent quite often have other incentives. Chemical and fiber savings may be realized from a system which was designed to improve the condition of the stream or body of water into which wastes are discharged.

The Committee Chairman, although recognizing the difficulty which may be experienced in outlining the completed mill programs to reduce the waste load carried by the effluent stream, assigned the following project to the representative from each participating mill.

Project: assigned in November, 1960

Prepare a report showing:

(a) capital expenditures, since 1950, exclusively for the improvements of mill effluent, and

(b) capital expenditures for systems, or equipment, installed mainly for reasons of an economic return, but that have also resulted in a reduction of the load carried by the mill effluent stream.

A review of various mill reports indicated that since 1950, a total of $11,501,500. has been expended by the five (5) Kraft Mills represented on this Committee. This total, expressed to confirm to the two-part nature of the project assignment, shows that a total of $945,500. was spent exclusively for the abatement of stream pollution (DIRECT expenditure), and $10,556,000. was spent for system installations, mainly for reasons of economic return, but where stream improvement is secondary, (INDIRECT expenditure).

It is noted that there is a wide range in capital expenditure, both directly and indirectly, for the improvement of mill effluents. This fact is explained when one considers the date of construction, the variety of products that are manufactured, the increased rate of pulp and paper production and the geographic location of each mill represented on this Committee. To up-date the older mills, to increase the rate of production, to install systems and equipment to minimize the waste load of the mill effluent streams and to maintain the mill waste disposal systems, involves a vast capital expenditure. Direct expenditures ranged from $92,000. to $445,000. for the ten year period after 1950, while indirect expenditures ranged from $36,000. to $2,800,000. The mills at the higher end of the cost range showed indirect expenditures due, in some part, to an increase in the rates of pulp production.

The major capital expenditures, since June, common to the majority of the Kraft Mills in this Northwestern Ontario group and claimed exclusively for the improvement of mill effluents, are accounted for by the installation and maintenance of the following systems:

(a) Stream surveys and a waste disposal monitoring system. Monitoring systems include sewer flow measuring systems, sewer sampling equipment located at strategic points in the particular sewer system, analytical equipment which permits a rapid detection of a source of high chemical loss, and in some instances, the installation of sensing elements in the overflow line from all strategic storage tanks.

(b) Installation of bark handling systems, to greatly reduce or eliminate a source of high solids disposal.

(c) Construction of lagoons, or settling ponds, for the removal of the pollutional load due to suspended solids.

(d) Installation of soap recovery systems, to remove a highly toxic component from Kraft mill wastes. The soap skimmings are used for tall oil production and, in one instance, as a fuel.

(e) Installation of foam breaking equipment, for mechanical and chemical destruction of foam, to reduce the chemical loss to sewer.

(f) Maintenance and operating costs for each particular effluent disposal system.

The major capital expenditures, common to the majority of the Kraft mills represented on this Committee, and claimed primarily for reasons of economic return, but that have also resulted in an improvement in mill effluents, are accounted for by the installation of the following systems:

(a) Knotter and screen rejects recovery.

(b) Lime Kiln, for the calcining of $CaCO_3$.

(c) Additional recovery furnace capacity.

(d) Turpentine recovery.

(e) Additional brown stock washer capacity.

(f) Additional evaporator capacity.

(g) Additional causticizing equipment.

(h) Fiber and solids recovery, where integrated operations exist.

The presentation and discussion of each mill report resulted in a second project assignment for the Committee which follows:

Project: assigned in February, 1961.

Prepare a report evaluating the installations claimed in the individual mill reports, i.e., indicate the reduction in the total waste load of the mill effluent stream.

A review of the mill reports presented during the meeting held in June, 1961, indicated that along with an increase in pulp production, ranging from 12% to 143%, there was a significant reduction in the total waste load of the mill effluent streams.

The percent reduction in the total load of the mill effluent streams, due to improved chemical recovery, ranged from 5% to 40% for sodium sulphate and from 17% to 70% for lime. In one case, the 70% reduction in the load, as lime, is attributed to the installation of a lime kiln. This same mill also reported a concurrent production increase equalling 143%. Another mill reported a reduction of 60% in load, as lime, in the mill effluent. This reduction was realized by a more effective operating procedure and by a more effective use of existing operating equipment.

One mill emphasized a 54% reduction in BOD of the total mill effluent sampled at the mill, between 1952 and 1960. Data, for the present chemical consumption and solids loss in the mill effluents, would indicate that other mills in our group may have a comparable reduction in BOD.

The reduction in fiber loss was difficult to evaluate. In most cases, the date that was presented made it difficult to compare fiber losses "before" and "after" a given installation. However, one mill, where an intergrated operation exists, did report a reduction in fiber loss of 48%, with an accompanying increase in pulp production of 64%. Another mill reported a reduction in suspended solids of 44%, with an increase in pulp production of 12%.

Chemical consumption and fiber loss, expressed as tons per day, will vary according to the rate of pulp production. A knowledge of the details of each individual operation is essential when reviewing the chemical consumption and fiber loss ranges, especially when the result is reported in terms of tons per day. A low chemical usage or fiber loss, expressed in this manner, does not necessarily indicate that a more effective chemical or fiber recovery system is in operation. The mill reporting at the high end of the range may have an equally efficient operation. For a comparison of operating and recovery

efficiencies, between mills in any one group, chemical consumption and fiber loss results would have to be reported in terms of loss per ton of pulp produced.

The present chemical consumption, expressed in terms of tons per day, varies from 17.8 to 51.1 for sodium sulphate, and 15.0 to 21.4 for lime. In all cases, where a mill fiber loss was reported, the loss is less than 2% of the total production, and ranges from 3.5 to 6.3 tons per day.

GENERAL:

From the date of formation of this Committee on September 26, 1960 to October 16, 1961, the Committee has held four (4) meetings. In so doing, some of the Committee members have visited our different mills, and others have visited three different mills represented in this Northwestern Ontario group.

It is the concensus of opinion that much value has been derived from these visits to participating mills. In each case, the mill waste disposal system was reviewed during the meeting, by one of the representatives from the host company. In addition, methods used to meter and sample sewer flows were described. A tour of the mill sewer sampling stations followed each meeting, at which time all could view the sampling equipment in operation. When weather conditions permitted, a tour of the mill waste disposal system was conducted.

There is no doubt that many new ideas were formed with regard to metering and sampling of sewer flows and reporting of measured losses. This free exchange of ideas, and the opportunity to evaluate existing sampling and stream improvement systems, will undoubtedly lead to continuing improvements in this important field.

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A PROGRESS REPORT

by

LAKEHEAD PAPER MILLS EFFLUENT IMPROVEMENT COMMITTEE

presented by

Chairman E.G. Pallister

November 14th, 1961

In 1959, meetings were held by the Paper Mills in and around the cities of Fort William and Port Arthur to discuss wastes and the effect these might have on local receiving bodies of water.

This lead to the formation, on June 24th,1959,(with the assistance of the Canadian Pulp and Paper Association Technical Section) of the Lakehead Paper Mills Effluent Improvement Committee. The members of this Committee are:

The Great Lakes Paper Co.Ltd.,	Fort William, Ontario
Abitibi Power & Paper Co.Ltd.,	Fort William Division
Abitibi Power & Paper Co.Ltd.,	Thunder Bay Division, Port Arthur
Provincial Paper Limited,	Port Arthur Division

Since that time this Committee has met on a monthly basis with two of the meetings held jointly with the Commissioners of the Ontario Water Resources Commission.

To assess the effect of pollution in the receiving waters from the Lakehead Mills, the member companies retained Mr. Thomas W.Beak, Consulting Biologist of Kingston, Ontario, to conduct a survey of receiving waters adjacent to the Mills.

An extensive survey was conducted by Mr.Beak in September 1959 including water sampling at various depths for chemical analysis and bottom sampling for biological analysis.

Mr. Beak reported that moderate pollution was occurring in the immediate vicinity of the Mill outfalls but recovery was occurring at relatively short distances. It was concluded that the pollution levels in the Lakehead area were less than had been originally expected.

To follow up this survey, a Testing Subcommittee was established to conduct further surveys to determine trends of pollution and to assess improvements which are being made by the member Mills.

To this end, a Professional Engineer from the Committee attended courses at Queens University to become familiar with latest techniques of water sampling and testing.

Under this direction, eleven surveys have been conducted. These surveys, while not as extensive as the one conducted by Mr. Beak,encompassed carefully chosen check points for each Mill.

These survey's showed, that while seasonal changes do occur, no overall trend toward worsening conditions is in evidence.

These chemical surveys will be continued at the rate of four per year at midsummer, midwinter and at the spring and fall turnover.

As the Great Lakes Paper Co.'s location is on the Kaministiqua River, the flow of which is controlled by the Ontario Hydro Commission, special considerations are evident.

In the spring, during periods of heavy spring runoff, special sediment removal equipment is required to remove silt and other material which makes the river water completely unsuitable for the manufacture of paper. During other periods, as necessitated by the requirements of the Ontario Hydro Generating Station located upstream, river flows are extremely low.

To determine whether these wide variations in flow were contributing to worsening pollution, Mr. Beak was again retained to conduct a second biological survey in the waters adjacent to the Great Lakes Paper Co.

This survey was completed in May of this year and the results showed very similar conditions to those which were found in the initial survey two years previously.

In addition, work is being conducted by the Testing Subcommittee on the improvement of waste measuring equipment within Mills and on the testing and measurement of mill effluents that could be considered potential pollution hazards.

Members of the Lakehead Committee are also active in the work being done by the CPPA Chemical Engineering Committee under whose jurisdiction waste reduction methods are being studied.

Since the formation of the Lakehead Committee, two briefs have been submitted to the Ontario Water Resources Commission.

The first of these, submitted in 1959, detailed the multimillion dollars of expenditures made by the member Mills in the post World War II years which had a direct bearing on pollution reduction. These items listed equipment purchased to recover and reprocess waste materials including such items as screens, refiners, etc.

Two items in this brief worthy of mention are the installation of equipment at the Great Lakes Paper Co. to recover, reprocess and burn bark. At Abitibi, Fort William Division the sulphite process was converted to a high yield process which effectively reduced the dissolved solids waste from this process to 40% of its previous level.

Some of the expenditures made by the member Mills are as follows:

(a) The Great Lakes Paper Co.

1. Four additional coarse screens with auxiliary equipment has been installed at a cost of $150,000. in the old section of the groundwood mill. This has allowed the groundwood screening system to be 100% closed and has eliminated loss from this system.

2. At a cost of $10,000. Parshall flumes have been and are being installed on the paper machine systems to evaluate losses from these systems. By adequate measurements, points of waste which contribute to the overall pollution picture can be traced to their source and eliminated.

3. At the present time the coarse screening system of the sulphite is being completely revamped and necessary equipment is being purchased to handle all the rejects from this system. Under existing conditions, all rejected knots and coarse fibre cannot be adequately handled but with the system being installed this system will be 100% closed. Cost of this project is $190,000. with the final stages scheduled for completion in November 1961.

4. In February and March of 1962, modifications are to be made to the wet ends of No's 1 and 2 Paper Machines whereby more efficient screens and possibly extra refining equipment will be installed with the net result being reduced wastes.

5. Projects now under study are: (a) investigations with regard to burning waste sulphite liquor, (b) investigations for more efficient screening of bark from mill effluents, (c) initial discussions with city officials with regard to the incorporation of domestic wastes into the eventual city effluent programme.

(b) Abitibi, Fort William Division

1. Installation of a new refiner in the groundwood system at a cost of $75,000. with consequent waste reduction.

2. Modifications made to the rich white water system at the sulphite filters have closed up this system by reclaiming rich white water at this point. The cost here was $3,000.

3. At a cost of $1,200, the Main Mill Sewer was re-routed to take better advantage of settling in the lagooning area to reduce the quantity of waste materials entering the Lake.

4. At a cost of $8,200. a sulphite blow liquor discharge line was installed to accomodate the spilling of waste sulphite liquor on land to allow oxidation of this material prior to its finding its way to the Lake. As this waste sulphite liquor has a very high biological oxygen demand this prior oxidation is an important step toward pollution reduction.

5. In 1961, $7,000. was spent dredging the bark pile area to ensure that this material did not find its way to the Lake.

6. In 1962, an additional refiner is being installed in the groundwood tailings system to completely close this system and eliminate fibre loss from this point. Cost of the project is $50,000.

7. An expenditure of $200,000. is proposed for 1962 to install bark handling and burning equipment to drastically reduce waste in the wood handling system.

(c) Abitibi, Thunder Bay Division, Port Arthur

1. In 1960 and 1961 repairs to the dam on the settling lagoon, clamming out the settling lagoon and trucking away recovered wastes has cost $7,200.

2. Annual use of defoamers added at the sulphite accepted stock tank solely to prevent overflow of fibre to the sewer costs $5,000. These are being used to replace kerosene and other objectionable organic materials.

3. Mill septic tanks have been cleaned out to prevent overflow. Cost for this was $1,500.

(c) Abitibi, Thunder Bay Division - continued

4. In 1961, repairs were made to the calcine flume and settling basin at a cost of $3,000.

5. New tile tanks in the sulphite rejects refiner system and new seal pits for the paper machines at a cost of $8,500. have reduced sewer wastes from these points.

6. Projects which will reduce sewer wastes and for which expenditure appropriations have been requested are:
 (a) improved bark handling and salvaging at a cost of $350,000.
 (b) additional refiners for groundwood and sulphite rejects at a cost of $115,000.

(d) Provincial Paper, Limited, Port Arthur Division

1. The installation of a Saveall on the No.6 Machine system at a cost of $80,000. has drastically reduced losses from this point. Improvements to this system to increase capacity has allowed the reclaimation and reuse white water previously sewered from No.5 Machine.

2. Retaining walls for a two stage lagooning system to process all sulphite and paper mill wastes are under construction.

3. A centricleaner system installed on the bleached sulphite system at a cost of $59,000. to replace obsolete screens has effectively reduced rejects and wastes from this system.

4. At a cost of $1,000., a reclaiming system has been initiated to recover starch used in the coating process which had previously been lost into mill effluents.

5. A trial installation of centricleaners on the rejects from the paper machine screen has been installed at a cost of $5,000. and has proved successful. Under study is a complete system at a cost of $100,000.

6. In 1962, the installation of pneumatic bulk handling equipment to handle all the clay used in the coating preparation plant is proposed at a cost of $70,500. This material is especially difficult to remove from mill effluents and the improvements in waste reduction will assist greatly in reducing objectionable mill wastes.

(d) Provincial Paper, Limited - continued

7. Improvements to the groundwood deckering system are being made at a cost of $20,000.

8. Other projected items which will affect sewer wastes are:
 (a) the replacement of obsolete broke handling equipment with new equipment. It is expected that the first phase of a proposed three phase project on this will be completed in 1962 at a cost of $86,000.
 (b) improvements to bark and wood handling equipment are under study.

In conclusion, it can be said that the Lakehead Paper Mills Effluent Improvement Committee has, by its formation and continued observance of mutual problems and studies of these on a sound scientific basis, kept the question of waste disposal as an integral part of mill operation.

The above items show that our mills are overcoming the difficulties on effluent purification which face us, so that we will conform to the high standards of water purity required in the Province of Ontario.

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A PROGRESS REPORT

BY

THE NIAGARA PAPER MILLS

EFFLUENT IMPROVEMENT COMMITTEE

presented by

R. Comette

on behalf of

Chairman S. F. Leishman

November 14th, 1961

C O M M I T T E E M E M B E R S H I P

Alliance Paper Mills Limited,	Merritton, Ontario.
Beaver Wood Fibre Company Limited,	Thorold, Ontario.
Garden City Paper Mills Company Limited,	Merritton, Ontario.
Interlake Tissue Mills Company Limited,	Merritton, Ontario.
Murray-Brantford Limited,	Thorold, Ontario.
Ontario Paper Company Limited,	Thorold, Ontario.
Provincial Paper Limited,	Thorold, Ontario.

I N D E X

1. INTRODUCTION

2. REPORT BY BEAVER WOOD FIBRE COMPANY LIMITED

3. REPORT BY ONTARIO PAPER COMPANY LIMITED

4. REPORT BY MURRAY-BRANTFORD LIMITED

5. REPORT BY PROVINCIAL PAPER LIMITED

6. REPORT BY INTERLAKE TISSUE MILLS COMPANY LIMITED

7. REPORT BY ALLIANCE PAPER MILLS LIMITED

8. REPORT BY GARDEN CITY PAPER MILLS COMPANY LIMITED

9. CONCLUSION

1. A REPORT BY NIAGARA PAPER MILLS EFFLUENT IMPROVEMENT COMMITTEE

Mr. Chairman, Members of the Ontario Water Resources Commission and Guests:

On behalf of the Niagara Paper Mills Effluent Improvement Committee I would like to present a report outlining some of the results that have been obtained by this group in the reduction of stream pollution in the Niagara Peninsula area.

The Mills, in order of their geographical location from South to North in the area of the Welland Canal, are - The Beaver Wood Fibre Co. Ltd.; The Ontario Paper Company Limited; The Murray-Brantford Limited; The Provincial Paper Limited; The Interlake Tissue Mills Company Limited; The Alliance Paper Mills Ltd. with two Divisions - Lybster and Lincoln; and the Garden City Paper Mills Company Ltd.

This is a very heavy concentration of mills producing a wide variety of pulp and paper products and they extend for a distance of approximately two miles along what was the Old Canal into which the effluent eventually sewers. The fresh water inlet for all these mills is taken from the present Welland Canal and the eventual destination of the effluent is via Twelve Mile Creek into Lake Ontario at Port Dalhousie.

This report will deal primarily with suspended solids of which each mill is a contributor.

We have been requested, in this presentation, to inform you as to what has been done since the instigation of the Committee in April, 1957, to reduce the pollution load from the mills and to tell you approximately how much has been spent and what results have been obtained. This purpose is best served by dealing with each mill separately and then in total.

2. REPORT BY BEAVER WOOD FIBRE COMPANY LIMITED

This mill operates two machines manufacturing paper board and the one for newsprint supplied by a Groundwood Mill and a system for repulping waste paper and purchased pulp. Modifications to decrease solids content of effluent have been made as follows:

1. Savealls under the board machine have been rebuilt.

2. Four flat screens and one Johnson Screen have been installed on white water recovery.

3. A cylinder decker has been installed on white water to the sewer.

4. All systems have been closed up by re-using more white water.

The total cost of the above is about $65,000.00.

It is estimated that the condition of the effluent has been improved by 25% overall with a higher recovery of coarse fibres.

3. REPORT BY ONTARIO PAPER COMPANY LIMITED

This is an integrated mill producing 675 tons per day of finished newsprint. As a result of this type of operation the pulp mills are in effect, employed as savealls for the paper mill with all rich paper mill white water re-cycling to the Groundwood Mill. Many steps have been taken in recent years to close up this system and to limit the loss of fibres. Since 1957 to date the fibre solids discharged per day have been reduced by 23.5% but during the last ten years they have been reduced by 42.7%.

A further step has been the elimination of rough wood from the mill and this has materially reduced the solids in the mill effluent.

Tests on the effluent from the Pulp Mill have shown that only 20% of the solids are re-useable. On the other hand, 60% is practically flour and passes through a 200 mesh screen. A great deal of money and work have been spent on eliminating the intermediate sized materials that originate in the wood room but, unfortunately, to date this project has not been successful. This problem is still being investigated and present indications are that a further reduction of five tons per day of solids will be made shortly.

During this same period from 1957 to date, major steps have been taken in the Paper Mill including a revision of the broke system, paper machine wire pits, Bird screen rejects and the re-cycling of surplus paper machine white water to the groundwood deckers. This latter modification, made in 1958, resulted in the reduction of about three tons per day in solids losses.

Many changes have been made in the refining centre including additional capacity, modified sumps, pumps and piping and these have all reduced considerably the quantity or rejects lost through equipment failures. Further studies are being made for continuation of this programme.

Ontario Paper Company Limited has, for many years, been active in research leading to the utilization of wastes. The Alcohol and Vanillin plants have done much to reduce the effluent load caused by waste sulphite liquor . During the past five years recovery of waste sulphite liquor has improved from 66% to over 80%.

Only 20% of this now goes directly to the sewers. In addition to their own waste sulphite liquor they are processing a portion of Alliance Paper Mill waste sulphite liquor to the limit of the Alcohol plant's capacity.

Effluent from the Alcohol plant is also made available for road binding for the benefit of local municipalities.

The Vanillin plant was expanded in 1959 and this has been an important factor in the further treatment of the waste for chemical recovery and pollution reduction. This program is still being actively pursued by the Research Department.

Engineering has been completed for the separation of domestic sewage from mill effluent. This will be followed up as soon as there are facilities available for the acceptance of this type of effluent.

Sixteen items are tabulated herewith on which there are accurate costs available. These total $340,842.00 that have been spent by the Ontario Paper Company Limited to assist in the elimination of pollution of the area waters and we are assured that Ontario Paper will continue their efforts to reduce pollution caused by their manufacturing operations.

GROUNDWOOD, SULPHITE & PAPER MILL EXPENDITURES

Item No.	Date	Description	Cost
1.	Dec. 1957	Groundwood white water storage tank to prevent surge losses	$82,336.
2.	Aug. 1958	Pump and piping to return excess paper mill water to groundwood mill	12,449.
3.	Dec. 1959	Pump, piping and equipment for supplying white water to Nos. 4 and 5 Machines	11,678.
4.	Jan. 1959	Pump and piping to supply white water to sulphite deckers	6,691.
5.	Nov. 1958	Pump and headbox for groundwood rejects	4,552.
6.	June 1959	Bauer refiner for groundwood rejects	44,766.
7.	Sept.1960	Jonsson screen to rescreen Bird screen rejects, Nos. 4 and 5 paper machines	12,084.
8.	Feb. 1961	Jonsson screen to rescreen Bird screen rejects, No. 3 paper machine	9,945.
9.	July 1960	Automatic Sewer samplers	1,688.
		Sub-Total	$186,189.

Item No.	Date	Description	Cost
		WOODROOM	
10.	1957	Testing 3 types of portable barker and purchase of one for Manitoulin limit. This reduced bark disposal at Thorold Mill.	$ 41,000.
11.	1959	Purchase of second portable barker for Manitoulin limit.	19,000.
12.	Dec. 1959	Installation of Sweco screens to clean up wood room effluent.	40,580.
		Sub-Total	$100,580.
		BY-PRODUCTS	
13.	Oct. 1958	Vanillin plant waste disposal pond	12,895.
14.	June 1959	Equipment to reclaim Alliance waste sulphite liquor for Alcohol plant	31,661.
15.	Dec. 1959	Equipment to improve lime mud recovery in Vanillin plant	3,113.
16.	Sept.1961	Conical settling tank to complete lime mud recovery program	6,404.
		Sub-Total	$ 54,073.
		TOTAL	$340,842.

4. REPORT BY MURRAY-BRANTFORD LIMITED

This is a smaller mill, producing an average of forty-five tons of coarse paper per day. During the past five years the loss of fibres to the sewage system has been reduced from seven to approximately two tons daily. This has been accomplished by closing the white water system and installing new Savealls equipped with finer wires. Domestic sewage has been separated from the industrial waste and will be tied in to local facilities when they are available.

The estimated cost of the improvements during this last five year period has been $30,000.00.

We are assured that further closing of the water system and reduction in the quantity of fresh water usage is planned for the future.

5. REPORT BY PROVINCIAL PAPER LIMITED

This mill is engaged in the manufacture of fine papers with a maximum production in the area of two hundred and fifty tons per day. The mill is only semi-integrated in that all long fibre is purchased from various sources throughout the continent. However, there is a de-inking plant designed for the recovery of fibre from waste paper which consumes up to one hundred tons of this type of furnish daily.

In the operation of a white or fine paper mill it becomes necessary to load some of the sheets very heavily with mineral mediums. This tends to unbalance the percentage of total solids in the effluent but the fillers have been considered as part of the solids for the purpose of this report. Since 1957 the solids lost in the mill effluent have been reduced from 14.3# to 10.4# to date for the present year. This is a reduction of about 35% in the solids per ton of paper produced and has been accomplished by the following items:

1. The use of vacuum washers in the Waste Paper plant to recover the white water solids from the paper mill.

2. Installation of a Saveall in the Waste Paper plant to recover the solids from coloured white water. These solids are then re-bleached and re-used.

3. Installation of fan type showers on the paper machines wire return rolls and head boxes reduced very materially the amount of fresh water used on the paper machines.

4. Two existing machines have had pressure type screens installed in place of the old Bird type with complete elimination of fresh water showers. A third machine will have this type of screen installed within the next two weeks and the fourth is scheduled for early in the New Year. The new paper machine was started up in October, 1961, with pressure type screens already installed.

5. Daily measurement of sewer effluent flows and analysis for solids are routine tests and this prevents any sewer from going out of control.

6. Installation of a Deculator on No. 7 Machine further reduced fresh water addition as no showers are used at the head box. The immediate indication is that there is very little white water surplus to the sewer on this new installation. It is planned to equip other machines in a similar manner if the efficiency continues to remain as high as it now apparently is.

7. The No. 2 Book grade or coated magazine stock which was formerly used in the de-inking plant has been practically eliminated. This item alone reduced the effluent by 3% on the total or roughly 10% of the de-inking plant total losses.

8. New flat screens were installed in the Waste Paper Recovery plant.

9. Bauer cleaners have been installed throughout the mill and, where possible, these are being operated with a tertiary stage.

The total cost of these items amounts to about $399,000.00 made up as follows:

1.	Piping for white water recovery to vacuum washers	$ 5,000.
2.	Installation of Saveall	65,000.
3.	Installation of Fan showers on machines	4,000.
4.	Pressure type screens	100,000.
5.	Routine	
6.	Installation of the Deculator and Cleaners	100,000.
7.	New flat screens in Waste Paper Department	50,000.
8.	Bauer Cleaners in the Waste Paper and throughout the mill	75,000.
	Total	$399,000.

6. REPORT BY INTERLAKE TISSUE MILLS COMPANY LIMITED

This is a tissue mill manufacturing toilet, napkins and towelling and they have shown much improvement in their total sewer losses over the past five years.

Production has increased in the Paper Mill and Groundwood Mill, yet in spite of this increase, the actual rate of loss has improved by 22.9%. This has been accomplished, primarily, by

engineering the changes in production so that approximately the same number of gallons of water are being consumed in total today as that being consumed for the smaller production five years ago.

This mill estimates that they have spent $19,500.00 to bring about this improvement and it is itemized as follows:

MILL EXPENDITURES FOR EFFLUENT IMPROVEMENT SINCE APRIL, 1957.

1.	Installation of weirs, sewer samples and flow recorders	$ 1,600.
2.	Installation additional Saveall, #3 Machine	12,000.
3.	Installation Saveall trays, #2 Machine	2,100.
4.	Piping and valves from Paper Mill to Groundwood Mill	850.
5.	Installation of control valves and piping, #3 Machine White Water System	750.
6.	Installation stock lines for sweetening stock to #1 and #3 Machine Savealls	150.
7.	Re-location and re-calibration of Flow Meter on Fresh Water Supply	300.
8.	Installation of connecting sewer from Groundwood Mill to Main Sewer	1,750.
		$19,500.

PROPOSED FUTURE IMPROVEMENTS

1. Alternations to #1 Machine Saveall Trays to reduce spillage.
2. Alterations to Paper Mill White Water Line to Groundwood Mill for Groundwood dilution.
3. Purchase of additional Saveall for #3 Machine.
4. Measurement of losses from Groundwood Mill.

7. REPORT BY ALLIANCE PAPER MILLS LIMITED

The Lybster Division of the Alliance Paper Mills Limited is composed of three machines on high grade papers and it is difficult to estimate the improvement in effluent losses as the necessary measuring devices have just been installed this Fall. Adequate records are not available but we can assure you that this mill is now in a position to accurately measure their effluent and they have spent $131,500.00 specifically for the control and elimination of solids in their Paper Mill and Pulp Mill effluents.

The sulphite Mill eliminated the use of rough wood in November, 1957, and trucks 10,000 to 15,000 gallons of waste liquor to the Ontario Paper Company Limited daily.

8. REPORT BY GARDEN CITY PAPER MILLS COMPANY LIMITED

This mill produces twelve tons per day of tissue and wrapping papers and approximately eight tons per day of vegetable parchment. They are non-integrated and all pulps are purchased from various suppliers. This mill, like the mills that have been previously mentioned, has been actively engaged in reducing their effluent losses; effecting a reduction of some 40% since 1957, at a total cost of $39,750.00.

With the exception of the separation of sanitary sewage from mill effluent, these changes have been designed to improve the operating efficiency by virtue of more efficient use of raw water and the reduction of mill losses in the effluent. Pollution abatement has been a prime consideration in every case.

9. CONCLUSION

This, Gentlemen, has been a report of theefforts put forth by the members of the Niagara Paper Mills Effluent Improvement Committee, and I believe you will agree with us that a great deal has been accomplished in the period of activity from 1957 to date. The total effort has cost these mills a grand total of $1,025,550. over the five year period.

All mills are aware of the situation and each and every one of us are endeavouring to find ways and means to further reduce the pollution of the streams in our areas. We assure you of our complete co-operation and will be glad to consult and co-operate with the Ontario Water Resources Commission at any time that you may see fit to call on us. Thank you.

SURVEYS AND EVALUATION

OF WASTE DISPOSAL PROBLEMS

PART I: "CONDUCT OF OWRC SURVEYS"

by

Fred A. Voege

Director of Laboratories

Ontario Water Resources Commission

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The surveys that Ontario Water Resources Commission personnel make, whether they be of open watercourses, municipalities or industries, are very important and are necessary to supply information for Ontario Water Resources Commission, International Joint Commission, industry and municipal use. However, since this meeting concerns the Commission and an industry primarily, my discussion will be restricted to topics dealing with those two.

The purpose of this discussion is to acquaint the industry with the overall aims and procedures of our surveys and to explain the reason behind everything we do in this regard. In planning a survey, it is important to consider (a) what information the Commission wants and needs, (b) what company is to be surveyed, and (c) when the survey is completed, what information can be supplied to assist the industry in its waste disposal.

The Commission is mainly interested in obtaining information regarding discharges from the industry and the effects that these discharges have on the receiving watercourses. It is important to know, if possible, processes that the company concerned could employ and the possible discharges and characteristics of these discharges that will have to be taken into account when sampling, transporting and analyzing the samples. Of lesser importance is the need to supply information to the company regarding their waste losses and the effect on the receiving body of water. This information is still important but most companies are becoming more and more aware of their losses as shown by their own surveys and are trying to reduce them. In most cases this was already done for the sake of economy but greater emphasis is being placed on all discharges and their effects. It is still important to show all the effects that a waste may have on the receiving body of water, such as causing bottom deposits, turbidity, de-oxygenation, temperature changes, taste, and mortality in aquatic organisms.

In the initial part of the survey at the company, more information must be obtained by the survey party to complete the picture and to determine the locations, sampling procedures, numbers, duration and analysis of the samples.

Some of this information is obtained by preliminary consultation with the officials of the firm before sampling begins.

This type of information would concern raw materials, processes, water supply, waste flows, duration of flows, work hours - by day and by week, and location of sewers. This type of information is most directly concerned with the taking of samples. The raw materials list will indicate what might show up in the waste spillage due to storage leaks, process failures, and equipment breakdowns. The information re-processes used will indicate the type of side reactions that might lead to wastes to the sewers; the normal product of these processes and what efficiencies are achieved and therefore what can be expected in the sewers; the duration of these processes - whether they are continuous or batch; when clean-ups of the various pieces of process equipment occur.

The water supply information is necessary so that some balance can be achieved regarding intake and discharge volumes. The quality of the raw water is necessary so the net discharge of certain contaminants can be determined. In a good many cases, but not all, the water being used has a good quality and this information is not important.

The waste flow volumes are very important in calculating the pounds per day of the various contaminants in the raw water and in the waste discharges. In certain instances the number of pounds per day being discharged is just as important as the concentrations since for certain types such as organic wastes, wastes with a high solids content, the effect may be long-lasting rather than immediate. These flows should be measured at the time of the survey and the best method is to use continuous recorders with accurately calibrated measuring devices such as weirs and flumes. It is realized that in some cases the velocity of the discharge is very great and it would be difficult to install such devices. However, before any definite plans can be made, if treatment is needed, these water volumes must be known. Therefore, it would be very helpful if the company would install measuring devices on all of their outlets.

To be able to sample when certain wastes are being discharged and not miss them entirely it is necessary to know the duration of the flows and when they occur. Some flows are continuous for 24 hours, others last as long as an 8-hour shift, others may be of short duration but occur 3 or 4 times a day and others may occur once a day either at regular or irregular times. Certain wastes occur during regular start-up and shut-down periods which may only happen once a week or even less frequently. Certain flows of short duration contain as much polluting material as may be found in a waste flow of a day's duration.

Linked with this is the information concerning the hours worked per day and per week.

Now that all the information has been obtained regarding the when and what, there still remains the where and how of the actual sampling. This involves locating the sewers and determining the areas that they serve. To apply the information gained about

duration of flows, processes, etc., it is necessary to know the areas served by the sewers so this information can be linked with a particular sewer. This will indicate how often the waste in a sewer should be sampled, whether duplicate samples should be taken for special analysis, whether grab samples taken at strategic times will convey more information than a composite over a whole day although both samples have to be properly evaluated. Similarly, some sewer outfalls may be dangerous to sample or discharge in such a manner that it would be practically impossible to obtain a representative sample. In this case it may be necessary to sample a number of tributary streams closer to the waste sources. In some cases this may not indicate the true discharge to the receiving body of water since it may be argued that mixing and aeration in the discharge sewer could alter the biochemical oxygen demand of the waste. However, it will be the best method under the circumstances.

Once it has been decided where to sample and when, there remains the task of collecting the sample. No doubt you are aware that the task group on sampling waste water of TAPPI has circulated a proposed method for sampling waste waters. Many of the ideas mentioned in that proposed method are similar to ones I am stating here. I would like to say here that I wrote this purely with OWRC procedure in mind but when I checked later with the TAPPI proposal we were in close agreement.

Since we do not have, at present, the means to install automatic samplers on the outfall sewers that have to be sampled most of our sampling is done manually. However, if the company has already installed them we will use them provided the company is agreeable and we feel that the sampling interval is adequate and the sample received is representative of the waste. If we use a company installed automatic sampler it is often on a sharing basis and the composite sample obtained is split between the company and the OWRC. Care must be exercised in the splitting of these samples so that each portion is truly representative of the composite sample. Adequate mixing of the sample is very necessary before each portion is taken off.

We feel that automatic samplers have definite advantages in sampling but they also have limitations. Therefore, we augment automatic sampling with manual sampling if necessary. This is especially so on sewers where the discharge of slugs may be encountered. When the slug does occur, a grab sample or samples collected during its passing often reveal more than the whole composition.

For this reason and the lack of enough automatic samplers of our own and the time to install them we also use manual sampling. In our manual sampling our personnel go from sampling point to sampling point on a schedule determined by the number of personnel available and the variable nature of the flow or concentration in the waste. It may be necessary to cut down the frequency of sampling at one spot so that another location can be visited oftener. The ideal way would be to have enough personnel to cover all the spots as often as desired. This is very seldom possible.

Usually, if a sewer being sampled carried the waste from a 24-hour process, the sample will be composited in 3 eight-hour portions, 1 shift at a time. This may make it possible to ship the composite from one or two shifts with a minimum of delay which is important for certain types of waste. If it is just a single-shift process the composite will be over that period. Sampling should take place as long as water usage occurs in order to get samples of start-up and clean-up losses.

We try and make each collection as representative of the waste stream and with as little variation over the period of sampling as possible. This means that we usually take the same amount of sample every time with no attempt at proportioning the sample to the flow. It may be argued that this will possibly weigh some composites unfavourably against the company but in an industry such as yours where the water flow is high and flow volumes not too variable this should not happen very frequently.

Sampling from barking machines or others that discharge large pieces of solids in the wastes poses special problems. Samples obtained are not always very representative unless collected in special ways. One method is to collect as large a sample as is convenient and physically possible, say, 2 gallons, with a bucket and then pour the waste through a 30-mesh screen. The filtrate is collected for compositing and the bark is saved for weighing later.

In order to assess the overall picture, samples of the receiving stream or lake are necessary. The samples should be collected above and below the point of discharge, or in the case of a lake, at and near this point and again at some distance away. If it can be arranged, samples should be taken of the stream bottom at the same time to show its condition and whether any deposition is occuring.

In the receiving watercourse, the extensiveness of the sampling depends again on the availability of personnel, and sampling equipment and the accessability of sampling points. The preferred method is to sample across the stream above and below at various depths and locations to show the path of the waste, if such esists and to show the distance that the effect is noticed. In addition to the sampling, dissolved oxygen analyses at these various sampling points will indicate the level of this substance, so that the effects on the aquatic organisms can be determined.

After the samples have been collected they are shipped as soon as possible to this laboratory to be analyzed. The analyses made most commonly on pulp and paper mill wastes and the stream receiving these wastes, are 5-day biochemical oxygen demand, total, suspended, dissolved, and ignited solids and pH. Other analyses may be for phenol, resin acid soaps, lignins and taste and odour. Consideration is also being given to the possibility of installing carbon adsorption units below mills to try and collect and identify some of the taste and odour producers that are being discharged into the water courses.

With these analyses and the waste volumes of the sewers it is possible to determine the contaminant loading from the various sewers and therefore to determine, if enough sampling points were used, which sewers are contributing the particular types of waste and how much. This information is useful if segregation is ever considered.

This combined information furnishes an indication of what effect the waste will have on the receiving body of water. The biochemical oxygen demand loading will indicate the amount of oxygen that is necessary to stabilize the wastes; this oxygen of course will have to come from the water in lake or stream, quite often to the detriment of the aquatic life therein. The suspended solids will indicate how much can be expected to be deposited on the stream bottom often producing sludge banks, or later rising as "mats", both of which are unsightly in a stream. Ignited solids can be used to measure the amount of fibre lost in the waste which is one measure of the efficiency of the mill operation.

Phenol determinations are made when we think that downstream use will be made of the water for domestic purposes. There is a number of thoughts regarding this - is it really phenol that is being recorded in the analyses or is it a degradation product of the wood chemicals that produces the same reaction with the indicators. This has not been definitely resolved. In any case, the importance of phenol lies with the fact that even in very small amounts in water it causes tastes when the water is chlorinated. Therefore, the taste and/or odour test should be used as the final criterion to determine whether a waste is causing a taste or odour or not and what dilution will be necessary before the taste or odour is reduced beyond perceptible concentrations. Resin acid soaps are toxic to fish and other organisms at low concentrations (1 ppm to 5 ppm) and therefore the concentration should be reduced below this level.

When all this information has been collected, it is reported with conclusions regarding the observations, analytical results and resultant pollution loadings and comparisons are made with previous surveys. With these in mind, recommendations are made concerning abating the pollution at the various sources, segrating the wastes, recovering certain waste components and, if possible, treating the wastes that would still need it.

This is offered as a guide to the Commission in its dealings with the company so that the best arrangements can be made toward the reduction of pollution.

SURVEYS AND EVALUATION

OF WASTE DISPOSAL PROBLEMS

PART II:

"A REVIEW OF THE PULP AND PAPER

WASTE PROBLEM IN ONTARIO"

by

R. H. Millest

Co-Supervisor, Industrial Wastes Branch

Ontario Water Resources Commission

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This review of the status of pulp and paper waste disposal in Ontario will undoubtedly appear to many here as a re-hash of material that has been discussed many times before. However, it is felt that it is usually worthwhile to stand back and look at as many aspects of the situation as possible, not only to re-examine the material at hand in the light of new information that may become available from time to time, but also to establish and maintain a common understanding which appears to be necessary in view of the many viewpoints which are held. There is no doubt that some of our views and impressions differ considerably with those held within the industry. The importance of industrial waste disposal to the overall problem of pollution control may well be recognized, but there will likely always be differences of opinion as to the best way to approach the situation, and bring about an effective and realistic control.

Much of the early effort in the study of stream pollution in Ontario was devoted, for the most part, to the study of waste discharges which had been long-standing sources of trouble and to the collection of data which would serve as an inventory to assess problems in specific areas. As area surveys were extended, it became possible to extract waste disposal information according to industry types, and this is now being done with respect to the pulp and paper industry, as well as plating and metal working, tanning, brewing and distilling, oil refining, mining, and other industries. It is felt that an overall appraisal of the problems confronting industries in similar groups is essential to the Commission in setting out an approach that can achieve its objectives and still remain realistic and feasible.

There are forty-one plants in Ontario engaged in the manufacture of pulp, paper, and paper products, including seven pulp mills, nineteen integrated pulp and paper mills, and fifteen paper mills. Total capacity is approximately 3,200,000 tons of products per year, exclusive of chemical by-products. Newsprint, at approximately 1,700,000 tons per year makes up the largest portion of the total as it does allacross Canada. Water consumption is estimated, from the information which has been gathered in our surveys, at something over 400,000,000 gallons per day. Most of this is discharged to surface waters as process wastes with little or no treatment. It is worth noting here, that data recently compiled by the U.S. Department of the Interior, indicate a considerably lower rate of water-use per ton of product in comparable pulp and

paper processes in the United States. Applying the average gallons of water used per ton of pulp produced in the United States to the production figures which we have in Ontario, it is estimated that water consumption for equivalent production in the United States would be approximately 313,000,000 gallons per day. This perhaps reflects only the greater need for re-use of process water in much of the United States industry, as a water conservation measure, rather than the reduction of water-use specifically through waste treatment or control.

Of more significance than actual water consumption data are the actual loadings of waste components that can be expected from the various processes. Measurement of the discharges of settleable solids, oxygen consuming components, toxic by-products, and taste-and-odour producing substances, shows a wide variation within the industry, but by using a few fairly well-established loading factors that are reasonably consistent throughout similar processes, it is possible to estimate the total waste loading of the industry, and, from that, predict the effects on the receiving waters.

Sulphite

Looking first at the sulphite process, the disposal of spent sulphite liquor, with its high oxygen demand, is still a major source of pollution in the industry. Although recent developments show promise of a practical solution to the disposal of this waste, most of the spent liquor is discharged without treatment in Ontario at the present time. The BOD loading ranges between 400 and 600 pounds per ton of sulphite pulp produced, giving a total of approximately 900,000 pounds of BOD per day being discharged to the receiving waters in Ontario. By comparison with sanitary sewage that can be expected in a municipal sanitary system, this level of BOD loading is equivalent to the BOD loading of the sanitary sewage from a population of 5,400,000. I hasten to add that this comparison is made only with respect to BOD, since sulphite liquor certainly does not have the other characteristics of sanitary sewage which are considered so objectionable as a source of pollution.

However, since the basic design data for most waste treatment plants or processes were initially established for sanitary sewage for which the various component loadings were well known, it is a matter of convenience in assessing the degree of treatment required to express any industrial BOD loadings in this way. It may be true that you can't compare apples and oranges, but I think you can safely compare BOD from various sources, as long as it is understood that you are speaking only of this one component.

Sulphate (Kraft)

Since the Kraft process is based on the recovery and re-use of cooking chemicals by evaporation and burning of the black liquor, there is much less discharge of the non-cellular components of the

wood to the sewer than in the sulphite process. As a result, the BOD loading is much lower, averaging about 40 pounds per ton of pulp produced, with another 40 pounds per ton contributed by bleaching. Except where dilution in the receiving waters is completely inadequate to satisfy even a moderate oxygen demand, the most important aspect of Kraft waste disposal is the loss or discharge of unrecoverable portions of the liquor, or components or by-products of it. The wastes are such that even small concentrations are extremely objectionable, some highly toxic to fish and other aquatic life, some imparting tastes and odours that persist in the receiving waters despite dilution and the exposure to the natural purification processes, and some producing foam which is characteristic of the wastes from the alkaline cooking of highly resinous or pitchy wood.

Groundwood

The production of pulp by the groundwood process gives rise to a comparatively low BOD loading (about 5 pounds per ton of pulp produced) and, since no chemical digestion is used, none of the toxic or taste producing by-products of the chemical pulping processes are encountered. The finely divided fraction of the pulp, or wood-flour, which passes through the screen or saveall systems, does have a detrimental effect however, in blanketing the bed of the receiving watercourse and limiting the growth of bottom organisms. This may appear to be a minor effect in large, fast flowing rivers, but to the aquatic biologist, who looks upon the production of fish food organisms as the basis of productivity of a body of water, such depositions when excessive, turn the receiving waters into a biological desert. The wastes from all of the paper making processes exert much the same effects on the receiving waters as does the groundwood process, with the added effects of fillers, sizes, dyes, etc., which may be used depending on the type of paper being produced.

Bark and Fibre

A great deal of process has been made in the control of bark as a waste, but it is still a most difficult problem at many mills. Looking into the question of bark disposal in some detail a number of years ago, we found that complete control at the mill itself would solve only a part of the problem, since bark is deposited throughout the waters in which the wood is carried from the woods operations to the mills. Although there is no simple solution to the problem, it is apparent that the removal of bark at the source, that is in the woods, would be necessary to eliminate bark from all waters. In the meantime, control at many mills would stand improving, even where recovery equipment is now in use. The loss of bark in transit appears to be something we will have to live with until an economical alternate to the present practice is found.

Some estimates of the quantity of bark that may be lost in transit were made a few years ago in an effort to evaluate the

importance of the problem. Assuming, for a moment, logs in 10,000 cord units, the bark on the rough wood at the source, at approximately 12 percent of the weight of the rough wood would amount to some 1,200 tons. Assuming half of this is lost in transit, approximately 600 tons are left in the watercourse where it will accumulate from year to year or be carried to estuaries where it would be deposited. Expanding this to a mill-use of 150,000 cords per year, suggest a potential loss of 18,000 tons to the waters in question. Now admittedly these are only approximations, but they do serve to show the magnitude of the problem.

Looking at the bark recovery at the mill, a loss of only 4 or 5 percent of the 18,000 tons still remaining on the logs would result in an annual loss of some 700 tons to the receiving waters at the mill.

The control of fibre is obviously a matter of utmost concern to the industry, and in most mills, in-mill recovery is practiced through the use of white water savealls of one type or another. It is the suspended solids not recovered by the savealls, and those originating in the pulping and bleaching operations that contribute heavily to stream loading, and require treatment beyond the pulp and paper making processes themselves. Fibre losses appear to range from approximately 2 percent to 7 percent throughout the industry, indicating a total loss in the over-all industry in Ontario of something between 300 and 1,000 tons per day, assuming most mills to operate with losses between 2 percent and 4 percent. For the industry as a whole, this is felt to be a very conservative estimate.

Looking briefly at some of the recovery and treatment methods available in the industry, it is obvious from a search of the literature that the problem at any one mill is not so much one of finding a system that will work, but rather of adapting practicable methods to the situation at hand. The following remarks are by no means intended to be a coverage of the waste treatment and control information, but rather some highlights of a few of the methods that appear to be applicable to problems in Ontario.

Chemical Wastes

Where land is available it would seem that the use of oxidation ponds or spray irrigation would serve to effect at least some control of strong wastes during a part of the year. Looking at spent sulphite liquor, some success has been achieved with spray irrigation, with a feed rate of 1 pound of spent sulphite liquor solids per square yard per day. At the Crown Zellerbach mill in Oregon as much as 60 to 80 tons of 8 percent sulphite liquor, diluted 1 to 8, was applied to an acre of silt loam soil each growing season without impairing the crop quality. The experiment showed that the land requirement was approximately 10 acres per ton of sulphite liquor to be disposed of. Sub-zero weather conditions reduced the efficiency, but did not prohibit operation.

In general, the minimum land requirement for the disposal of spent sulphite liquor appears to be about 0.5 acres per ton of production.

Applying this method of disposal to Kraft waste, one mill sprayed the combined evaporator and digestor condensates and causticizing dregs from the plant on 70 acres of high permeability soil. Seven laterals on each side of the main feeder line, spaced at 200 feet intervals, with 200 gallons per minutes spray nozzles located at 200 feet along each lateral, were used for the disposal of a million gallons a day of segregated effluent. The waste was first stored in a 60-day lagoon where an 80 percent reduction of BOD (to approximately 219 parts per million) was effected prior to spraying. The disposal site was sprayed in 10 acre plots with each 10 acre plot being sprayed for 8 hours each day at 2,000 gallons per minute for a total of 3.6 inches application per day. The mean application rate was 14,000 gallons per acre per day or 0.53 inches per day between April and November. This was raised during one summer to between 1 and 1.3 inches per day. This entire programme, as were those at other mills using this method of disposal, was carried out with very close attention to the maintenance of a good cover crop. In addition, spraying in a wooded area appeared to produce no harmful effect on the trees. The installation costs of this million gallons per day set-up was $75,000, with a daily operating cost of $5.00 or 6 cents per ton of production. Similar installations for combined pulp and paper mill flows increase the cost-per-ton figure, with 20 cents to 35 cents per ton indicated in the literature.

The use of oxidation ponds, which have taken on great importance in the field of sanitary waste disposal, is receiving close attention in the pulp and paper industry, particularly in the disposal of spent sulphite liquor. Because of the extremely high BOD loadings, the area requirements are much greater on a volume basis than those normally considered in sanitary sewage, so that depths of up to 15 feet have been used. This means a combination of aerobic and anaerobic action, and presettling is necessary to reduce the sludge and maintain a balance between aerobic and anaerobic conditions. It has been found that the BOD should not exceed 500 parts per million, although summer loading can be much higher. In many of the American mills BOD loadings as high as 130 pounds per acre per day have been used, giving a BOD reduction of about 80 percent in 20 days. This is about 2½ times the recommended loading for a sewage lagoon. Relating this to the expected loading from a 100 ton sulphite mill, a lagoon with an area of about 300 acres would be required.

Considerable attention has been given to the use of spent cooking liquors as a roadbinder, and, although this is usually thought of in terms of spent sulphite liquor, it has been used for the disposal of semi-chemical black liquor as well. Since this is in the form of an accomplishment at the Hinde and Dauch mill at Trenton, I am sure the company will not object to my referring to it.

After an experimental application as a roadbinder, two ponds of 8.2 U.S. million gallons and 4.8 U.S. million gallons with 142 and 83 days retention respectively, were built to store the 30 to 40 gallons per minute flow of black liquor from the Pressafiners. The company built seven 2,500 gallon tanks that could be mounted on platform trucks and provided pumping and overhead loading facilities so that municipalities could collect the waste and haul it away for application. All tanks were loaned out to get the programme started, and no charge was made of the liquor itself. In the first full season of operation the ponds were completely emptied by September and the demand exceeded the supply until freeze-up. One trucker, having lost a contract to haul calcium chloride, purchased two 2,500 gallon tank trucks and contracted anew to treat the roads in the same township a distance of 50 odd miles from Trenton. In 1960, a total of 12 municipalities used the black liquor as road-binder, with the rate of application at approximately 2,500 gallons per mile of road.

Solids

Four principal methods of removing solids are available: flotation, filtration, sedimentation, and contact reaction. Of these, only filtration is in common use, if we consider fine screening and the use of savealls in this category. Flotation is most applicable to fine paper mill wastes where the use of china clay and other fillers produces a highly turbid effluent. Contact reaction is based on the principle of up-flow through a sludge blanket which acts as a filter medium. Solids are drawn off the chamber at the desired level and reintroduced into the process. Sedimentation, either in conventional, mechanically cleaned equipment, or in earthen settling basins that are cleaned by earth moving equipment, would appear to be most applicable to most of the Ontario mills where land for this purpose is available. The fibre removed in this way cannot normally be recovered for re-use unless a small pre-settler is first used so that the recovered fibre can be returned to the porcess without delay.

Whenever solids removal facilities are employed without re-use, it is generally advisable to establish two or more basins in parallel, so that they can be used alternately. The design should be such that they can be cleaned from the sides with conventional earth moving equipment. Where sedimentation basins are used to dewater sludges from clarifiers or other such equipment, a one month filling period to a depth of 3 or 4 feet, and a two months dewatering and drying period, followed by the removal of solids, is recommended.

Further to the use of oxidation or waste stabilization ponds, it has been found that aeration in the pond, or between ponds in series, can cut the required retention time in half and thereby minimize the space requirements. Removal of solids prior to lagooning also effectively minimizes the size requirements, since

BOD reductions of between 10 percent and 15 percent can be so obtained. Comparing settling or oxidation ponds with mechanical clarifiers and sludge disposal, the following data are of interest:

Settling Ponds

For a flow of 20 MGD, an area of about 10 acres would be required, with application of waste to a depth of about 6½ feet and a retention time of 21 hours. A reduction of suspended solids of between 80 percent and 85 percent is possible based on experience in the U.S., with an influent concentration of 270 parts per million and an effluent of 46 parts per million.

Mechanical Clarifier

A mechanical clarifier of approximately 250 feet diameter and a depth of 18 feet, with a retention time of about 6 hours would effect about the same degree of treatment. Cost of the latter, with sludge disposal facilities, would probably be in excess of $250,000 while that for an oxidation pond would vary, depending on the type of land available.

One could go on at length, extracting data from the literature, but it is enough here to conclude that the problem in Ontario, as it is throughout the industry, is a formidable one, with no immediate prospect of a complete solution. It is difficult to suggest costly treatment beyond the pulp and paper mill processes, when the ultimate goal of recovery and re-use of wastes in the production of by-products is the desired goal. However, it does not seem likely that the final answers in this direction will come without a complete overhaul of present processes and facilities, and in the meantime, some means of suitably minimizing present waste loadings should be considered through methods that will still find application in controlling residual wastes from recovery processes in the future.

SECOND DAY

November 15, 1961

DISCUSSION

In the discussion, concerning the papers presented the previous day by Messrs. Voege and Millest, the question of interpretation of BOD results and the use of the sewered population equivalent was raised. Where a stream carrying industrial waste empties into a large river a short distance downstream from the industry, the effect of the BOD is quickly dissipated. Thus time factor does not apply since the conditions implied in the 5-day test are not obtained in practice for that period of time. Immediate Oxygen demand would perhaps be of much more significance. The use of population equivalent was felt to imply, in the minds of the general public at least, a similarity to sanitary wastes. While the concept is quite valid for evaluating relative BOD loadings, it was pointed out that the public and the press refuse to differentiate between bacteriological and biochemical pollution. It was suggested that it would be preferrable to use another name which would differentiate clearly between bacteriological and biochemical types of pollution.

The point was then brought out that, whereas BOD may be dissipated before it has had effect on the main receiving water, the time element suggests that there would be instances where greater than 5-day oxygen demand would be important. Each case should perhaps be examined on its own merits, then, to establish where the BOD may produce a critical effect in the one to ten-day range.

The importance of population equivalent as a means of evaluating progress from year to year was stressed both as a means of determining improvement at a single industry and to demonstrate to the public the main sources of BOD loading.

BIOLOGICAL SURVEYS IN POLLUTION MEASUREMENT

by

T. W. Beak

Consulting Biologist

Collins Bay, Ontario

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This paper is intended to serve a double purpose:-

1. To describe the studies of the Ottawa River undertaken by the Ottawa Effluent Improvement Committee.

2. To illustrate from these results how biological surveys can be used to measure pollution in a large river.

The principal date sources for this paper are two surveys carried out in 1960, one extending from Lake Deschene to the west end of Lake of Two Mountains, the other extending through the latter lake. These are supplemented by chemical studies made at the same time by the member compaines of the Committee.* However, a number of other studies have been made in previous years by individual companies before the settling up of the Committee and these results have been made available to me for this paper. These further studies include the following:-

1. Biological studies of the Ottawa River above and below Hawkesbury 1956 and 1959 (Sponsored by Canadian International Paper).

2. Biological studies of the Ottawa River above and below Gatineau 1957 and 1958 (sponsored by Canadian International Paper).

3. Chemical studies of the Ottawa River below Gatineau and Hawkesbury mills undertaken by C.I.P. staff 1954 to 1960 inclusive.

4. Chemical studies in the Ottawa River by the E. B. Eddy Company 1958.

* The following companies are members of this Committee:-

Canadian International Paper Company.
E. B. Eddy Company,
Industrial Cellulose Research Limited.
James MacLaren Paper Company.
Rolland Paper Company.
Thurso Pulp & Paper Company.
J. G. Wilson Limited.

Biological and chemical studies were also made in the Lievre River in 1956 and 1960 for the James MacLaren Co. Ltd., and in the North River in 1960 for the Rolland Paper Company and J. G. Wilson Limited. These studies were, of course, entirely in Quebec.

It will be appreciated from this list that in writing this paper I have suffered from an embarrassment of data, and my hardest task has been one of selecting which should be excluded in order to keep the length of the paper within the prescribed thirty minutes.

Under the heading "Objectives for Water Quality Control in Ontario" the Ontario Water Resources Commission has set out the following general objectives.

> "All wastes, including sanitary sewage, storm water and industrial effluents, shall be in such condition when discharged into any receiving waters that they do not create conditions which will adversely affect the use of these waters for the following purposes:- sources of domestic water supply, navigation, fish and wildlife, bathing, recreation, agriculture and other riparian activities."

Any method of measuring water pollution, if it is to be competent in Ontario, must measure the extent of adverse effect on some or all of these activities. Let us first examine how the biological survey method described in this paper measures up to this requirement.

As used by me, the method does not include measurement of bacterial contamination. This is because I have been principally concerned with the measurement of the industrial wastes' contribution to pollution. As most of the bacterial contamination comes from domestic sources I have not included it. It is this bacterial contamination which would be critical in the Ottawa River in affecting its use as a source of drinking water and also for bathing.

The method described here gives a direct measurement of adverse effects on fish and wildlife and indirectly on other activities listed. What is in fact being measured is the overall biological health of the river and this is closely related to the value of the waters for all the purposes listed. The method, therefore, gives a good general picture of the overall condition of the river.

In an ideal world where money was no object and any amount of staff and effort could be allocated to a river survey one would study many aspects including the following - attached and floating algae, bottom living animals, large plants, fish, other wildlife (wild fowl, mammals) and chemical conditions over an extended period. Such a survey would require the services of a large number of specialists over a long period,

and apart from the prohibitive cost, it is very doubtful that they could be brought together for the purpose. I have, however, come to the conclusion that in practice the best return in results for a given outlay of money and effort is obtained by a study of the macro-invertebrate animals living on the bottom, together with such chemical analyses as can reasonably be carried out as a supplement.

Let us go directly to these Ottawa River surveys and see how this method has been used to measure the extent to which wastes have adversely affected the use of the river, apart from these effects due to bacterial contamination.

The basic theory behind the use of this method is that any body of natural water in an unpolluted state will support a characteristic fauna of small animals associated with the bottom. This fauna will include several species which differ markedly in their ability to tolerate changes brought about by pollution. When a stress - such as pollution - is applied to the environment the less tolerant species will be reduced in numbers or eliminated first, and the proportion of the whole community so affected is a measure of degree of pollution. There are several complicating factors, one of the most frequently encountered being that when some species are eliminated competition for the remainder is reduced and these tend to increase in numbers. In extreme cases there may be only one or two species remaining and these in very large numbers.

METHODS OF SURVEY

The basic survey requirements is to obtain a representative quantitative sample of the bottom and its inhabitants. Taking into account varying depths, (down to 200 feet at one point in the Ottawa), currents, distances (this survey covered over 100 miles of river) and such obstacles as falls and rapids, the physical difficulties of this can be very real. The apparatus which has been found to be most generally useful is the Petersen dredge operated from a fair-sized boat. This is illustrated in Fig. 1. It consists of a clam-like dredge which is lowered to the bottom with the jaws open. On touching bottom a pawl is released and as the apparatus is raised the jaws dig into the bottom and remove approximately one square foot of it and convey it to the surface.

The sample is usually sieved in the boat and the animals and some debris which remain on the sieve (30 mesh) are put in containers, preserved and returned to the laboratory for analysis.

On arrival at the laboratory the animals are carefully hand-picked from the debris, identified and counted. The results are then carefully analysed and from them, together with other pertinent data such as chemical analyses, conclusions on the condition of the river are drawn.

Discussion of Results

Fig 2 illustrates the part of the Ottawa River studied. It extends for approximately 100 miles from above Ottawa to its confluence with the St. Lawrence.

Apart from the larger cities of Ottawa and Hull there are many smaller communities from the size of Hawkesbury (9000 population) down to very small villages. The major industrial plants are the Eddy Company Paper Mills at Ottawa and Hull, the C. I. P. integrated wood products plant at Gatineau, the Thurso pulp mill, at Thurso, and the C. I. P. pulp mill at Hawkesbury. There are also the MacLaren pulp and paper mill on the Lievre and the Rolland Paper Company and J. G. Wilson Company mills on the North River, which are tributaries.

I propose first to show some of the raw data as it appears when sorting and identification are complete and follow through the various methods of analysis of the data to illustrate how this is used to form conclusions on the condition of the river.

Table 1(a) shows the breakdown of numbers of animals found in the six samples, each of 1 square foot, on a sand - silt bottom in Lake Deschenes upstream of Ottawa. The actual names of the organisms are of little interest, except to biologists, but the grouping on the pages is important. The group 3 organisms are those which from experience have been found to be most intolerant of pollution. The Group 2 organisms include the faculative species which occur in clean water, but can tolerate varying degrees of pollution. Some of these will increase in numbers at certain stages of pollution. Group 1 organisms are those which have the greatest tolerance, and although they occur in small numbers in clean water, their most important characteristic is that they are often found in very large numbers in conditions when all, or nearly all, the more intolerant species have been eliminated.

Looking at this table it will be seen that there is a fairly even distribution of Group 3, Group 2, and Group 1 species. This is typical of an unpolluted community. Table 1(b) illustrates the communities in a muddy bottom in Lac Deschenes. Although there are differences in species distribution within the groups there is still very good distribution between the groups.

Table 1(c) shows the results obtained immediately below Chaudiere Falls - i.e., above any of the pulp mill effluents, but below some of the Ottawa sewers. Without analysis it is obvious that there is a change in that most of the Group 3 organisms are missing and there is an increase in numbers of some of Group 2.

Table 1(d) shows a continuation of this process moving downstream to the Interprovincial Bridge below further pollution sources. In spite of this there is still a fairly representative fauna, particularly in midstream. Table 1(e) shows the results from two miles further downstream and shows signs of improvement in that more Group 3 organisms have returned.

Tables such as these were prepared for each of the nineteen stations in the river and seventeen further stations in the Lake of Two Mountains. Most of these stations had three sub-stations, namely, on the north side of the river, in the middle and on the south side. Let us now turn, therefore, to the ways this raw data is analysed.

Several methods of analysis are available and to some extent the choice of method depends on the data and the information required from it. In this case the data has been analysed in four different ways. It will be seen that apart from minor variations due to the differences in sensitivity of the analysis the results are very similar using the four methods.

All four methods basically aim at converting the raw data to a form in which it can be illustrated graphically. They differ in the graphical form, but they are all illustrating the basic changes which take place in the community under pollutional stress.

METHOD 1.

The end product in this method is a map with a code showing the pollutional stress at the various points in the area. Fig 3 is an example. We shall return to this later, but first let us look at the intermediate steps by which we get from the raw data to the form shown.

This depends on a conception which I have called biological score. It will be remembered that in the raw data tables the animals were arranged in three groups. A score is attached to each group of samples on the basis of the presence or absence of animals of each group as follows:-

NORMAL NUMBER OF GROUP 1 ORGANISMS	1 POINT SCORE
NORMAL NUMBER OF GROUP 2 ORGANISMS	2 POINT SCORE
NORMAL NUMBER OF GROUP 3 ORGANISMS	3 POINT SCORE
TOTAL POSSIBLE	6 POINTS

The scores are additive so that a normal community as shown scores 6 points. If only Group 1 and Group 2 animals are present the score will be 3 points and if only Group 1 animals are present the score will be 1 point.

Sometimes a few but not a normal number of Group 3 or Group 2 organisms will be present and then a reduced score is arbitrarily applied, for example, 1 instead of 3 points for a reduced number of Group 3 organisms.

This biological score is now used to construct a graphical illustration of the results. The code is based on a small circle divided into 6 segments. The score is illustrated by the number of segments which are left white - thus 6 is represented by all white, 5 by 5/6 white and so on. The code and the conditions it is taken to illustrate are shown in Fig 4. It will be seen than an estimate of river use is given beside each score. It must be emphasized that this does not include uses affected by bacterial contamination.

Applying this to the Ottawa River in 1960 we can see the conditions found to occur at this time based on this biological survey.

METHOD 2

This method also depends on the use of the biological score, but instead of developing a code on a map the results are shown in an ordinary graph with the score on the ordinate and miles downstream or upstream of a data line on the axis. In Fig 5 the continuous line shows the results/by this method it will be seen that there is an area of depression for approximately twenty five miles downstream on the north side of the river, whereas the recovery is much quicker on the south side.

METHOD 3.

This is based on a method described by Wm. Beck Jr. of Florida. In this method the animals are divided into two groups. Group 1 includes approximately my Groups 1 & 2 and Group 2, my Group 3. He counts the number of species in each group and calculates the score from the formula.

$$2n_2 + n_1 = \text{Biotic Index}$$

Where n_2 = number of species of Group 2

n_1 = number of species of Group 1

The broken line in Fig 5 shows the results for the Ottawa River illustrated by this method. Taking into account the rather considerable differences of analysis the results are in quite good conformity.

METHOD 4

Method 4 differs from the others in that it is a direct graphical illustration of species and does not depend on the intermediate step of deriving a score.

In Fig 6 the species are arranged in the same groups as in the raw data, intolerant at the top and tolerant at the bottom. The area blacked in oposite each family or sub group, illustrates the number of different species found.

The method offers an overall graphical representation of results. The gaps are fairly obvious at a glance and a good general picture of the condition of the river as a whole and the changes along its length is obtained.

I want now to review some of the chemical data which has been obtained by the various member companies of the Committee and compare it with the O.W.R.C. Survey in 1954 and then draw all this together into a brief summary of conditions in the Ottawa River at present as I see them.

All but one of the pulp mills (the Thurso mill), are basically sulphite and groundwood mills. I have carried out fairly extensive tests with sulphite liquor, I have made a careful study of the literature and I have discussed this matter with many people who have worked with it and I am quite sure that so far as freshwater fish are concerned the sole significance of waste sulphite liquor is its oxygen absorbing capacity. At any concentration at which it does not completely deoxginate the water it is not toxic. Due to lack of research I cannot say that there are not possibilities of some insidious effects on invertebrates such as appears to be the case with oysters, but the biological surveys look after this aspect. Therefore, so far as the sulphite mills are concerned, the most important chemical tests are B.O.D. and dissolved oxygen. Suspended solids are also important with all pulp and paper mills, but due to lack of time I have excluded that aspect from the paper. I shall, therefore, confine myself to data on these two aspects of chemical pollution. The single kraft mill is small compared to the size of the river and as the biological surveys do not show any evidence of toxic effects from this, I think we can for the present paper restrict consideration to these tests for the river as a whole.

Due to the large amount of data at my disposal I am going to be very selective. Fig 7 shows the dissolved oxygen data obtained, both in the studies made in connection with this survey and also those by the O.W.R.C. in 1954. It does not include all the data collected, but I have tried to make it representative. Fig 8 shows the B.O.D. data collected. In the continuous line the results are for the survey and the broken line shows results obtained by O.W.R.C.

I submit that there is no significant contradiction between the chemical data we have - both our own and the O.W.R.C. - and the biological data. I hope I have also demonstrated that the clearest way of summarising the results is to go quickly through the graphical illustrations developed under Method 1 - the blacked in circles on the map. The code is there in illustration in Fig 4.

Now let us run quickly through the figures showing how this code can be applied to the section of the Ottawa River and Lake of Two Mountains down to the confluence with the St. Lawrence River.

This is illustrated in Figures 3, 9, 10, 11, & 12.

CONCLUSIONS

It is undoubtedly difficult to summarise the conclusions from so much data in a few words, but I shall try.

My opinion of what this means is this.

So far as the general biological health of this section of the Ottawa River is concerned, excluding bacteriological contamination.

1. There is a section of the river immediately below Ottawa in which the combined effects of the domestic sewage from the cities of Ottawa and Hull and the industrial wastes bring the river to the point where a significant increase in pollutional load would cause a breakdown of biological communities and of biological health.

2. Except for one or two isolated areas where mixing is incomplete, the biological communities, although stressed to the point where the more intolerant organisms have been forced out, do not indicate an existing state of serious deterioration and in particular I do not think that in the present state sport fishing would be seriously adversely affected except possibly in very isolated areas.

3. Proceeding downstream the waste assimilative capacity of the river asserts itself so that by the time Thurso is reached it has returned biologically to a satisfactory condition.

4. Apart from a few isolated points - for example below Hawkesbury, before mixing of effluents from the town and mill with the river is complete - this condition is maintained down to Lake of Two Mountains.

5. Except for one or two very local points around the lakeside communities, there is biologically no evidence of adverse pollutional effects in the Lake of Two Mountains.

6. The Ottawa River does not make a significant contribution to the pollution of the St. Lawrence River around Montreal - excluding possibly (and I have no data on this) some bacterial contamination.

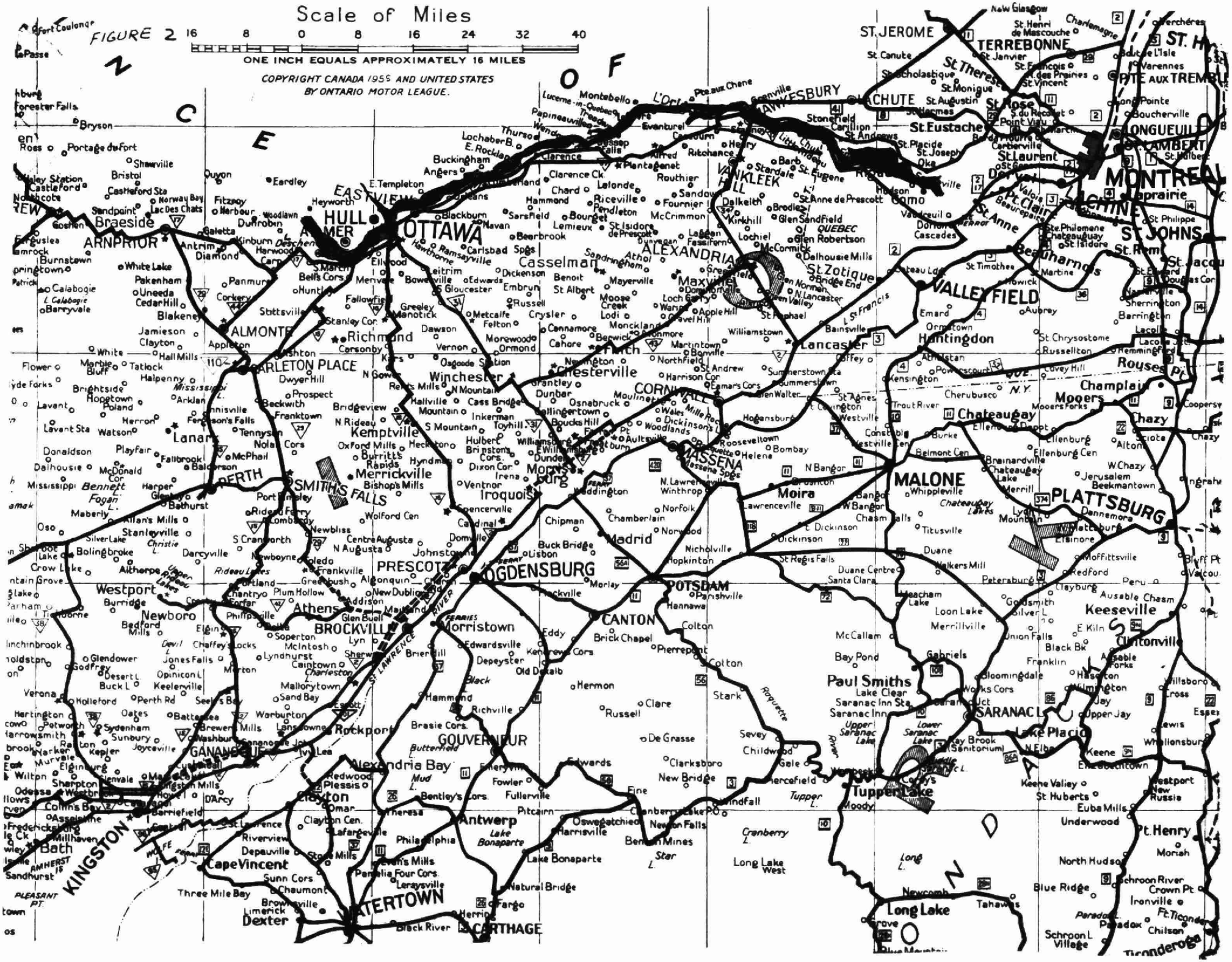

Scale of Miles
16 8 0 8 16 24 32 40
ONE INCH EQUALS APPROXIMATELY 16 MILES
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NEW YORK
OTTAWA
HULL
EASTVIEW
ALEXANDRIA
CASSELMAN
MAXVILLE
VANKLEEK HILL
LANCASTER
VALLEYFIELD
HUNTINGDON
ST. JEROME
TERREBONNE
LACHUTE
MONTREAL
LONGUEUIL
ST. LAMBERT
ST. JOHNS
BEAUHARNOIS
CHATEAUGUAY
HUNTINGTON
ROUSES POINT
CHAMPLAIN
MOOERS
CHAZY
PLATTSBURG
MALONE
MASSENA
MORRISBURG
IROQUOIS
PRESCOTT
OGDENSBURG
POTSDAM
CANTON
MORRISTOWN
BROCKVILLE
ATHENS
SMITHS FALLS
PERTH
ALMONTE
ARNPRIOR
RICHMOND
CARLETON PLACE
KEMPTVILLE
MERRICKVILLE
WESTPORT
NEWBORO
RICHMOND
CHESTERVILLE
WINCHESTER
CORNWALL
MADRID
MOIRA
MALONE
PLATTSBURG
PAUL SMITHS
SARANAC LAKE
LAKE PLACID
TUPPER LAKE
LONG LAKE
SARANAC INN
LAKE CLEAR
KEESEVILLE
CLINTONVILLE
ELIZABETHTOWN
WESTPORT
NEW RUSSIA
ST. HENRY
MORIAH
CROWN PT.
IRONVILLE
FT. TICONDEROGA
CHILSON
SCHROON RIVER
NORTH HUDSON
BLUE RIDGE
UNDERWOOD
EUBA MILLS
ST. HUBERTS
KEENE VALLEY
KEENE
WILMINGTON
JAY
UPPER JAY
BLOOMINGDALE
FRANKLIN
BLACK BK
UNION FALLS
MERRILLVILLE
LOON LAKE
MEACHAM LAKE
GOLDSMITH
SILVER L.
AUSABLE CHASM
MOFFITTSVILLE
REDFORD
CLAYBURG
PERU
PETERSBURG
DUANE
DUANE CENTRE
SANTA CLARA
WALKERS MILL
ST. REGIS FALLS
NICHOLVILLE
HOPKINTON
NORWOOD
NORFOLK
CHAMBERLAIN
LISBON
BUCK BRIDGE
CHIPMAN
MORLEY
PARISHVILLE
HANNAWA
COLTON
BRICK CHAPEL
PIERREPONT
EDDY
EDWARDSVILLE
DEPEYSTER
OLD DEKALB
HERMON
CLARE
RUSSELL
STARK
DE GRASSE
CLARKSBORO
NEW BRIDGE
FINE
CRANBERRY LAKE
NEWTON FALLS
BENSON MINES
OSWEGATCHIE
HARRISVILLE
CHILDWOLD
SEVEY
GALE
EDWARDS
FIERCEFIELD
WINDFALL
MOODY
LONG LAKE WEST
NEWCOMB
TAHAWUS
LONG LAKE
SCHROON L. VILLAGE
PARADOX
PARADOX L.
ANTWERP
LAKE BONAPARTE
PHILADELPHIA
THERESA
ALEXANDRIA BAY
CLAYTON
REDWOOD
PLESSIS
OMAR
BENTLEY'S CORS.
FULLERVILLE
FOWLER
ELLERYVILLE
GOUVERNEUR
ROCKPORT
BRASIE CORS.
BUTTERFIELD
HAMMOND
RICHVILLE
BROWNVILLE
LIMERICK
DEXTER
BLACK RIVER
CARTHAGE
FARGO
HERRINGS
NATURAL BRIDGE
LERAYSVILLE
PERCELIA FOUR CORS.
KEVIN'S MILLS
STONE MILLS
SUNN CORS
CHAUMONT
THREE MILE BAY
CAPE VINCENT
DEPAUVILLE
RIVERVIEW
ST. LAWRENCE
LAFARGEVILLE
CLAYTON CEN.
COLLINS BAY
KINGSTON MILLS
HARROWSMITH
ODESSA
ELGINBURG
MILLHAVEN
BATH
AMHERST I.
PLEASANT PT.
SANDHURST
GANANOQUE
GANANOQUE JCT.
IVY LEA
LANSDOWNE
RAYMOND
SHERWOOD
CHARLESTON
MALLORYTOWN
SAND BAY
WARBURTON
BREWERS MILLS
SEELEY'S BAY
HOLLEFORD
PERTH RD
OPINICON L.
KEELERVILLE
DESERT L.
BUCK L.
JONES FALLS
CHAFFEY'S LOCKS
MCINTOSH
LYNDHURST
CAINTOWN
MORTON
GLENDOWER
GODFREY
OATES
BATTERSEA
SYDENHAM
PETWORTH
SUNBURY
JOYCEVILLE
HARKER
MURVALE
ELGINBURG
WILTON
SHARPTON
ODESSA
COLLINS BAY
KINGSTON
MILLHAVEN
BATH
AMHERST I.
PLEASANT PT.
SANDHURST
FREDERICKSBURG
ASSELSTINE
CARRIFIELD
HOWE I.
WOLFE I.
ROCKWOOD
GANANOQUE
GLEN BUELL
ADDISON
MAITLAND
NEW DUBLIN
PLUM HOLLOW
CHANTRYO
FARFAR
PHILIPSVILLE
ELGIN
SOPERTON
LYN
BROCKVILLE
ATHENS
NEWBORO
BEDFORD MILLS
WESTPORT
BURRIDGE
CROW LAKE
ALTHORPE
SILVER LAKE
STANLEYVILLE
OSO
MABERLY
ALLAN'S MILLS
BOLINGBROKE
DARCYVILLE
NEWBOYNE
TOLEDO
FRANKVILLE
GREENBUSH
ALGONQUIN
CHIPMAN
MORLEY
PARISHVILLE
HANNAWA
COLTON
BRICK CHAPEL
PIERREPONT
EDDY
EDWARDSVILLE
DEPEYSTER
OLD DEKALB
HERMON
CLARE
RUSSELL
STARK
DE GRASSE
CLARKSBORO
NEW BRIDGE
FINE
CRANBERRY LAKE
NEWTON FALLS
BENSON MINES
OSWEGATCHIE
HARRISVILLE
CHILDWOLD
SEVEY
GALE
EDWARDS
FIERCEFIELD
WINDFALL
MOODY
LONG LAKE WEST
NEWCOMB
TAHAWUS
LONG LAKE
SCHROON L. VILLAGE
PARADOX
PARADOX L.
ANTWERP
LAKE BONAPARTE
PHILADELPHIA
THERESA
ALEXANDRIA BAY
CLAYTON
REDWOOD
PLESSIS
OMAR
BENTLEY'S CORS.
FULLERVILLE
FOWLER
ELLERYVILLE
GOUVERNEUR
ROCKPORT
BRASIE CORS.
BUTTERFIELD
HAMMOND
RICHVILLE
BROWNVILLE
LIMERICK
DEXTER
BLACK RIVER
CARTHAGE
FARGO
HERRINGS
NATURAL BRIDGE
LERAYSVILLE
PERCELIA FOUR CORS.
KEVIN'S MILLS
STONE MILLS
SUNN CORS
CHAUMONT
THREE MILE BAY
CAPE VINCENT
DEPAUVILLE
RIVERVIEW
ST. LAWRENCE
LAFARGEVILLE
CLAYTON CEN.
COLLINS BAY
KINGSTON MILLS
HARROWSMITH
ODESSA
ELGINBURG
MILLHAVEN
BATH
AMHERST I.
PLEASANT PT.
SANDHURST
FREDERICKSBURG
ASSELSTINE
CARRIFIELD
HOWE I.
WOLFE I.
ROCKWOOD
GANANOQUE
GLEN BUELL
ADDISON
MAITLAND
NEW DUBLIN
PLUM HOLLOW
CHANTRYO
FARFAR
PHILIPSVILLE
ELGIN
SOPERTON
LYN
BROCKVILLE
ATHENS
NEWBORO
BEDFORD MILLS
WESTPORT
BURRIDGE
CROW LAKE
ALTHORPE
SILVER LAKE
STANLEYVILLE
OSO
MABERLY
ALLAN'S MILLS
BOLINGBROKE
DARCYVILLE
NEWBOYNE
TOLEDO
FRANKVILLE
GREENBUSH
ALGONQUIN
CHIPMAN
MORLEY
PARISHVILLE
HANNAWA
COLTON
BRICK CHAPEL
PIERREPONT
EDDY
EDWARDSVILLE
DEPEYSTER
OLD DEKALB
HERMON
CLARE
RUSSELL
STARK
DE GRASSE
CLARKSBORO
NEW BRIDGE
FINE
CRANBERRY LAKE
NEWTON FALLS
BENSON MINES
OSWEGATCHIE
HARRISVILLE
CHILDWOLD
SEVEY
GALE
EDWARDS
FIERCEFIELD
WINDFALL
MOODY
LONG LAKE WEST
NEWCOMB
TAHAWUS
LONG LAKE
SCHROON L. VILLAGE
PARADOX
PARADOX L.

FIGURE 2

Table 1 (a)

LOCATION: Above Chaudiere Falls.
Off Britannia Park Beach - about 100 yds. off shore.

STATION: 1A

Sample Reference No.	347	346	345	344	343	342	No. Species
GROUP 3 Organisms (intolerant)							
Ephemeroptera (Mayflies)	5	10	2	5	2	14	2
Trichoptera (Caddis flies)	2	-	1	4	-	5	2
Coleoptera larvae (Beetles)	9	4	4	5	3	7	1
GROUP 2 Organisms (faculative)							
Tendipedidae (Midge larvae)	118	138	53	93	24	121	10
Pelecypoda (clams)	117	90(4)	52	63	31	99(1)	3
Gastropoda (snails)	4	16	8	3	4	4	5
Amphipoda (scuds)	91	148	48	58	24	158	1
Isopoda (sow bugs)	-	-	-	-	-	-	1
Planaria (flat worms)	3	2	-	-	-	-	2
Hirudinea (leeches)	-	-	-	1	-	2	1
Oligochaeta (worms) faculative sp.	-	-	-	-	-	-	1
Oligochaeta (worms) Tolerant species	282	26	38	78	277	39	2
Total species							31
Type of bottom	Sand and silt.						

Table 1 (b)

LOCATION: Above Chaudiere Falls, about 1/2 mile from Britannia Park - close to channel leading to Yacht Club.

STATION:	1 B.						No. Species
Sample Reference No.	341	340	339	301	338	337	
GROUP 3 Organisms (Intolerant)							
Ephemeroptera (Mayflies)	32	25	16	14	20	36	2
Trichoptera (Caddis flies)	7	3	7	7	18	23	4
Coleoptera larvae (Beetles)	6	3	-	-	2	12	1
GROUP 2 Organisms (faculative)							
Tendipedidae (Midge larvae)	21	20	20	11	27	39	10
Pelecypoda (clams)	12	15(1)	27	14	31(2)	47(4)	4
Gastropoda (snails)	-	1	2	1	6	-	2
Amphipoda (scuds)	5	-	-	-	-	-	1
Isopoda (sow bugs)	-	-	-	-	-	-	-
Planaria (flat worms)	-	-	4	1	3	3	1
Hirudinea (leeches)	1	-	-	-	-	-	1
Oligochaeta (worms) faculative sp.	-	-	-	-	-	-	-
GROUP 1 Organisms							
Oligochaeta (worms) tolerant species	7	17	19	14	19	48	2
Total species							28
Type of bottom	Mud						

Table 1 (c)

LOCATION: Immediately below Chaudiere Falls.

	North side.				South side Victoria Is.				South side - back of Parliament Buildings.			
STATION:	2A			No.	2B			No.	2C			No.
Sample Reference Rd. No.	143	152	155	sp.	144	163	162	sp.	164	165	166	sp.
GROUP 3 Organisms (Intolerant)												
Ephemeroptera (Mayflies)	-	1	-	1	-	?	-	-	-	-	-	-
Trichoptera (Caddis flies)	4	-	-	2	-	1	-	1	-	-	-	-
Coleoptera larvae (Beetles)	3	1	-	1	-	2	-	1	-	-	-	-
GROUP 2 Organisms (faculative)												
Tendipedidae (Midge larvae)	671	500+	52	4	104	26	257	5	6	-	1	3
Pelecypoda (clams)	20	44	8	1	3	13	7	1	-	-	-	-
Gastropoda (snails)	9	4	3	5	14	141	6	3	40	53	7	7
Amphipoda (scuds)	13	4	1	1	-	-	-	-	18	1	8	1
Isopoda (sow bugs)	71	19	4	1	-	-	1	1	71	3	105	1
Planaria (flat worms)	-	-	-	-	4	-	1	1	30	3	3	2
Hirudinea (leeches)	3	3	1	2	-	47	4	1	5	2	7	2
Oligochaeta (worms) faculative sp.	-	-	-	-	-	-	-	1	-	-	-	2
GROUP 1 Organisms												
Oligochaeta (worms) tolerant sp.	11	1	6	1	376	93	451	2	162	22	31	
Total species				19				17				18
Type of bottom:	Silt and sand, some wood debris.				Muddy, some wood debris. Smell of oil.				Hard with some weeds.			

Table 1 (d)

LOCATION: Near Interprovincial bridge.

STATION:	North side upstream N.R.C. buildings. 3A		Centre - just downstream Ottawa Racing Club. 3 B				S. side, in bay East of Ottawa Racing Club. 3C			
Sample Reference No.	Bag 33	No. sp.	115	114	116	No. sp.	134	153	154	No. sp.
GROUP 3 Organisms (Intolerant)										
Ephemeroptera (Mayflies)	-	-	-	-	-	-	-	-	-	-
Trichoptera (Caddis flies)	-	-	1	-	1	1	-	-	-	-
Coleoptera larvae (Beetles)	-	-	-	-	-	-	-	-	-	-
GROUP 2 Organisms (faculative)										
Tendipedidae (Midge larvae)	9	1	288	31	203	5	4	-	-	3
Pelecypoda (clams)	-	-	24	2	91	1	-	-	-	-
Gastropoda (snails)	-	-	8	-	7	3	-	4	2	2
Amphipoda (scuds)	-	-	30	14	17	1	15	3	1	2
Isopoda (sow bugs)										
Planaria (flat worms)	-	-	32	1	8	2	64	10	2	1
Hirudinea (leeches)	27	2	11	5	9	3	4	29	13	1
Oligochaeta (worms) faculative sp.	-	-	-	-	-	-	-	-	-	1
GROUP 1 Organisms										
Oligochaeta (worms) tolerant species	90	1	25	5	18	1	49	4	2	1
Total species:		5				18				12
Type of bottom:	Mud and wood debris.		Bark and wood debris.				Wood debris.			

Table 1 (e)

LOCATION: West end of Kettle Island.

STATION:	N. side - about 100 ft. from bank. 4 A				By log boom at W. end of Island. 4 B				S. side - 200 yds. E. of Ottawa canoe club. 4 C			
Sample Reference No.	49	52	53	No. sp.	57	59	60	No. sp.	61	63	64	No. sp.
GROUP 3 Organisms (Intolerant)												
Ephemeroptera (Mayflies)	-	-	2?	1	-	-	-	-	-	1	Sample thrown away	1
Trichoptera (Caddis flies)	3	-	3	1	-	-	-	-	3	-		1
Coleoptera larvae (Beetles)	3	-	-	1	-	-	-	-	-	-		-
GROUP 2 Organisms (faculative)												
Tendipedidae (Midge larvae)	15	3	137	4	12	67	55	5	47	7		2
Pelecypoda (clams)	22	2	26	2	1	3	2	1	5	4		1
Gastropoda (snails)	8	-	15	3	1	8	2	5	9	2		4
Amphipoda (scuds)	-	-	2	1	-	2	-	1	201	72		1
Isopoda (sow bugs)	9	3	13	1	-	3	-	1	1401	329	No Formalin	1
Planaria (flat worms)	7	2	21	2	-	-	-	-	47	21		1
Hirudinea (leeches)	-	10	5	2	-	1	2	1	54	18		3
Oligochaeta (worms) faculative sp.	-	-	-	2	-	-	-	-	-	-		-
GROUP 1 Organisms												
Oligochaeta (worms) tolerant species.	31	3	73	1	5	30	15	1	127	31		1
Total species:				21				15				16
Type of bottom:	Sandy with silt and weed.				Sand.				Bark and wood debris.			

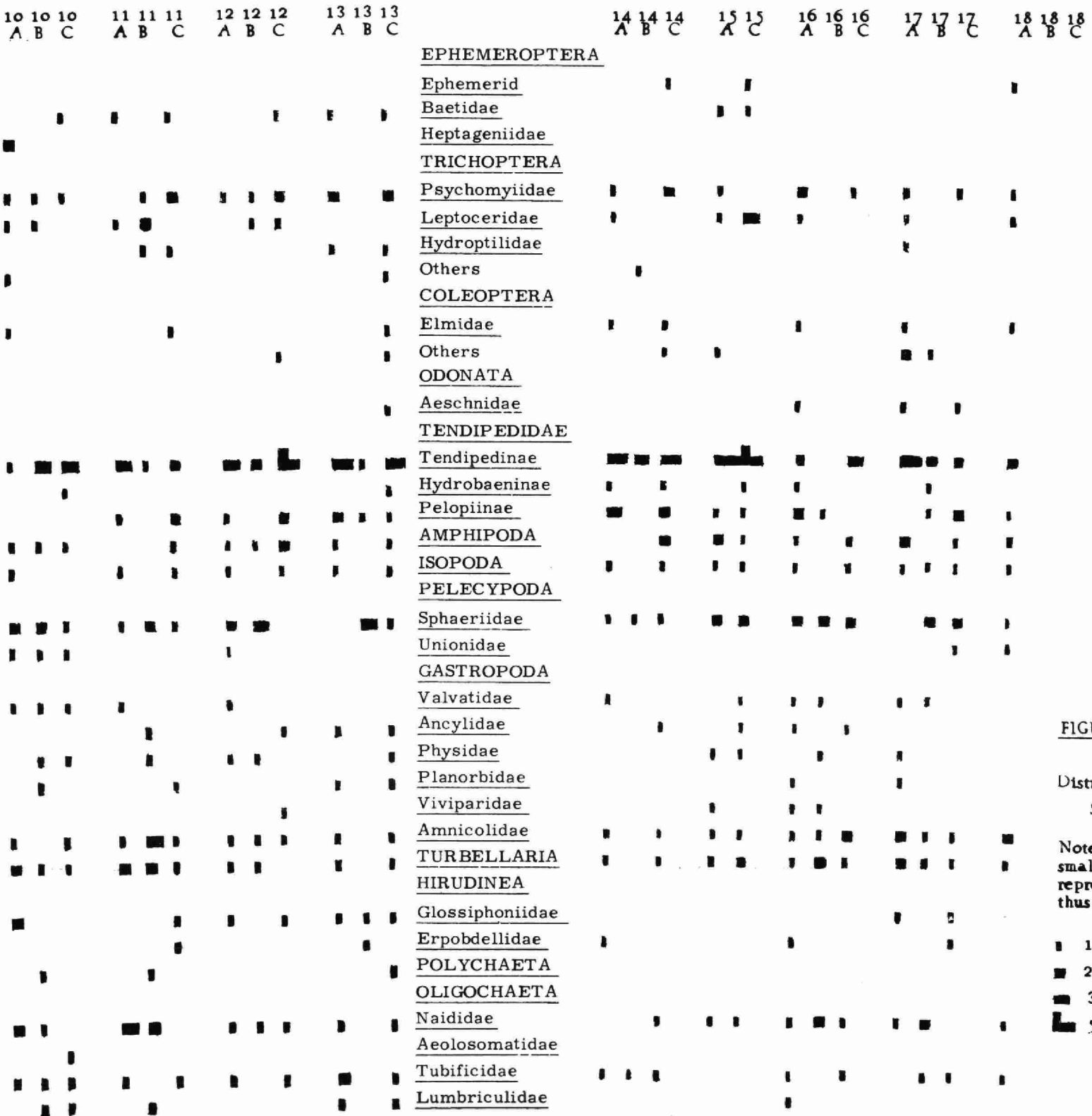


FIGURE 6

Distribution of Species

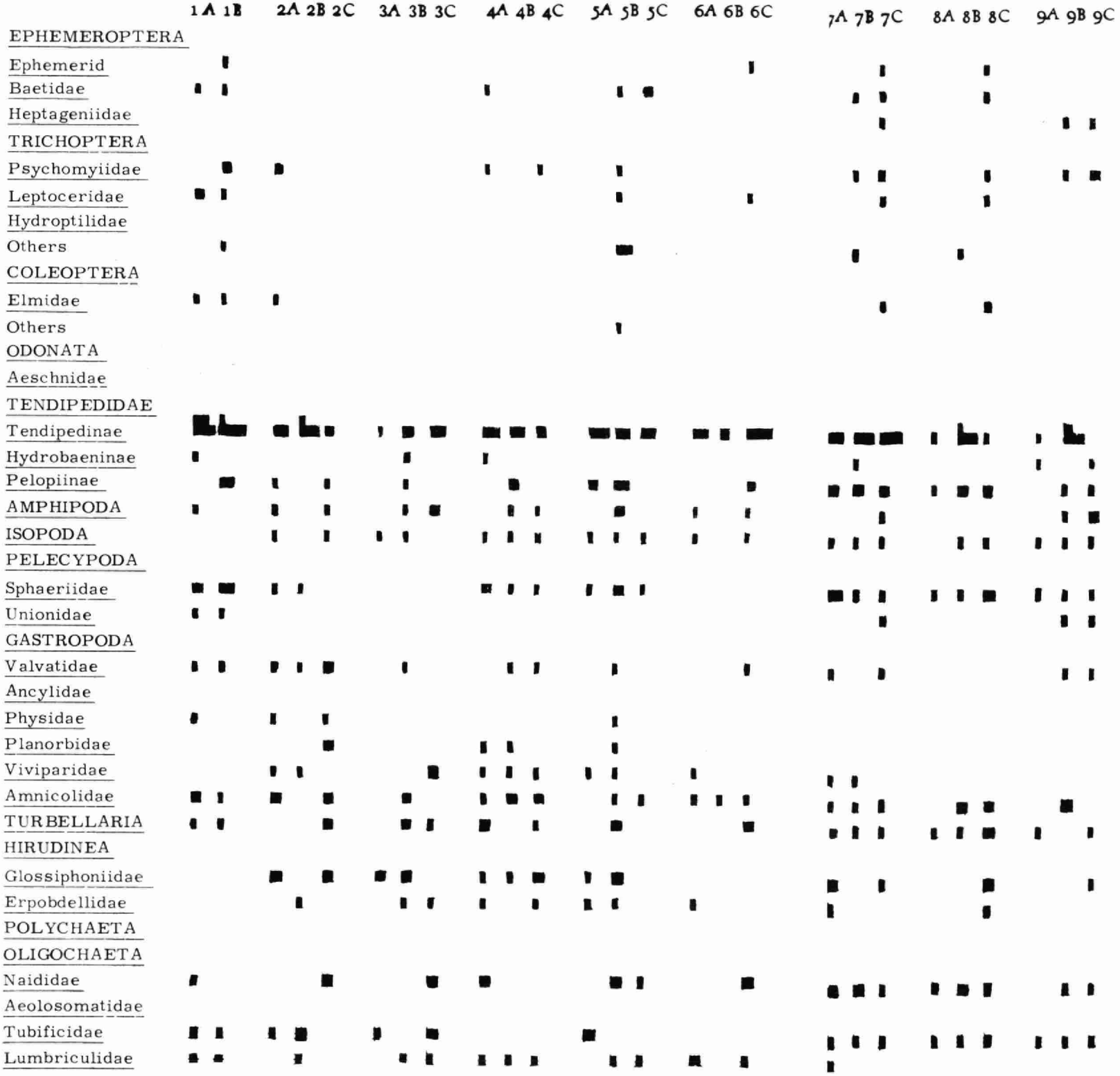
Note:- Each 2 small squares represents 1 sp. thus:-

1 sp.

2 sp.

3 sp.

5 sp.


1A 1B 2A 2B 2C 3A 3B 3C 4A 4B 4C 5A 5B 5C 6A 6B 6C 7A 7B 7C 8A 8B 8C 9A 9B 9C
EPHEMEROPTERA
Ephemerid
Baetidae
Heptageniidae
TRICHOPTERA
Psychomyiidae
Leptoceridae
Hydroptilidae
Others
COLEOPTERA
Elmidae
Others
ODONATA
Aeschnidae
TENDIPEDIDAE
Tendipedinae
Hydrobaeninae
Pelopiinae
AMPHIPODA
ISOPODA
PELECYPODA
Sphaeriidae
Unionidae
GASTROPODA
Valvatidae
Ancylidae
Physidae
Planorbidae
Viviparidae
Amnicolidae
TURBELLARIA
HIRUDINEA
Glossiphoniidae
Erpobdellidae
POLYCHAETA
OLIGOCHAETA
Naididae
Aeolosomatidae
Tubificidae
Lumbriculidae

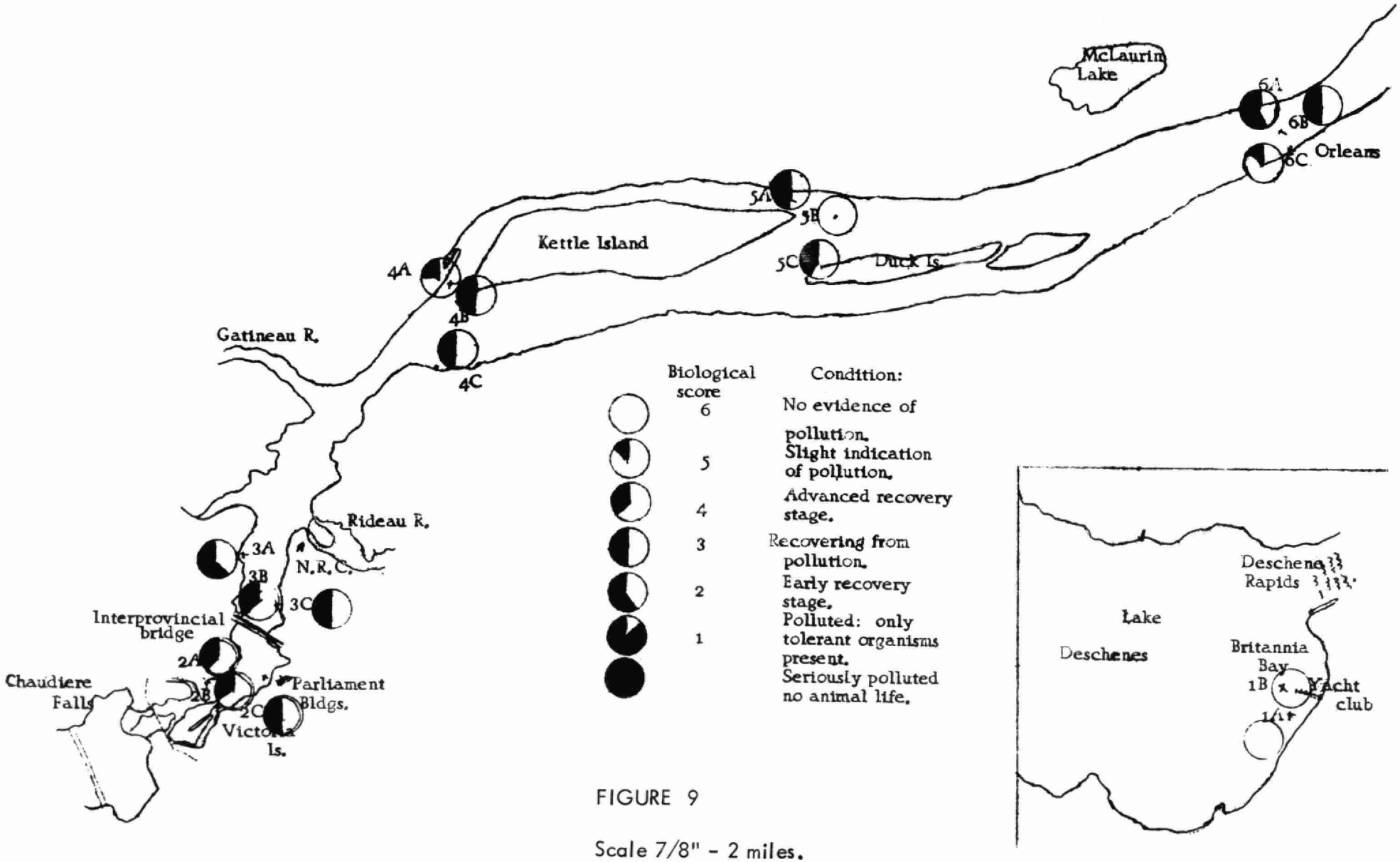


FIGURE 9

Scale 7/8" - 2 miles.

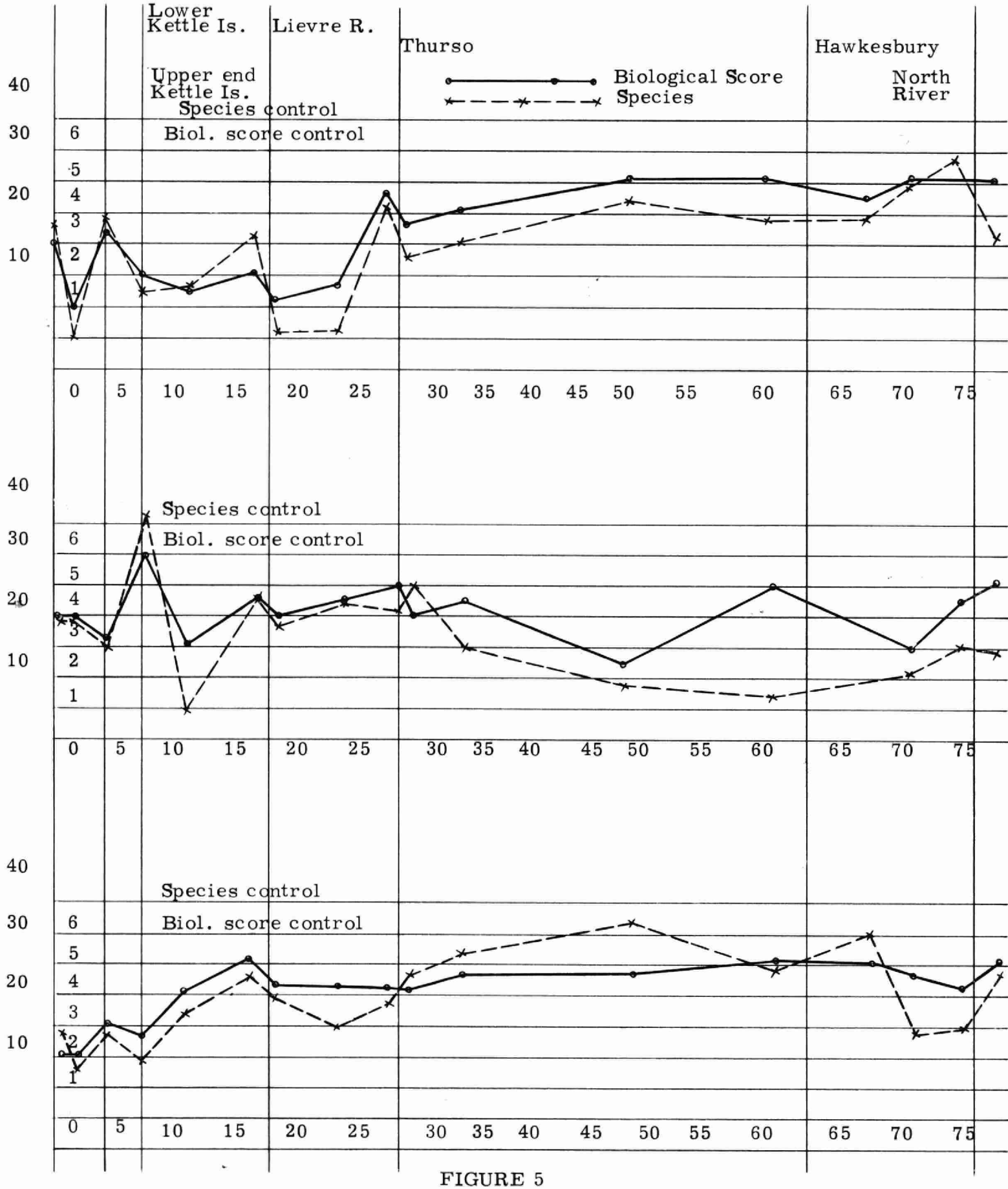


FIGURE 5
Biological score and adjusted number of species

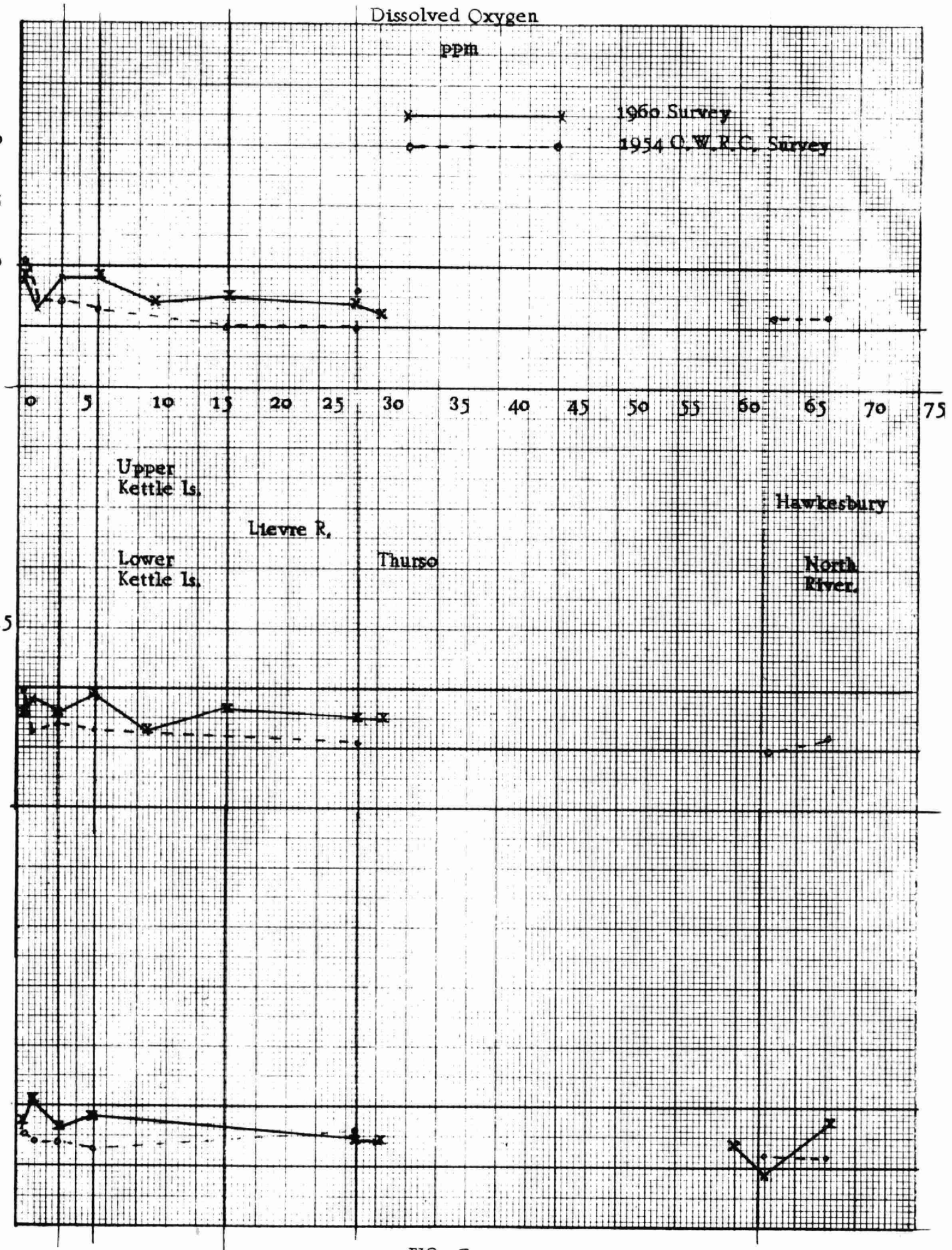

Dissolved Oxygen
ppm
1960 Survey
1954 O.W.R.C. Survey
20
15
10
5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Upper
Kettle Is.
Lievre R.
Lower
Kettle Is.
Thurso
Hawkesbury
North
River.

FIG. 7

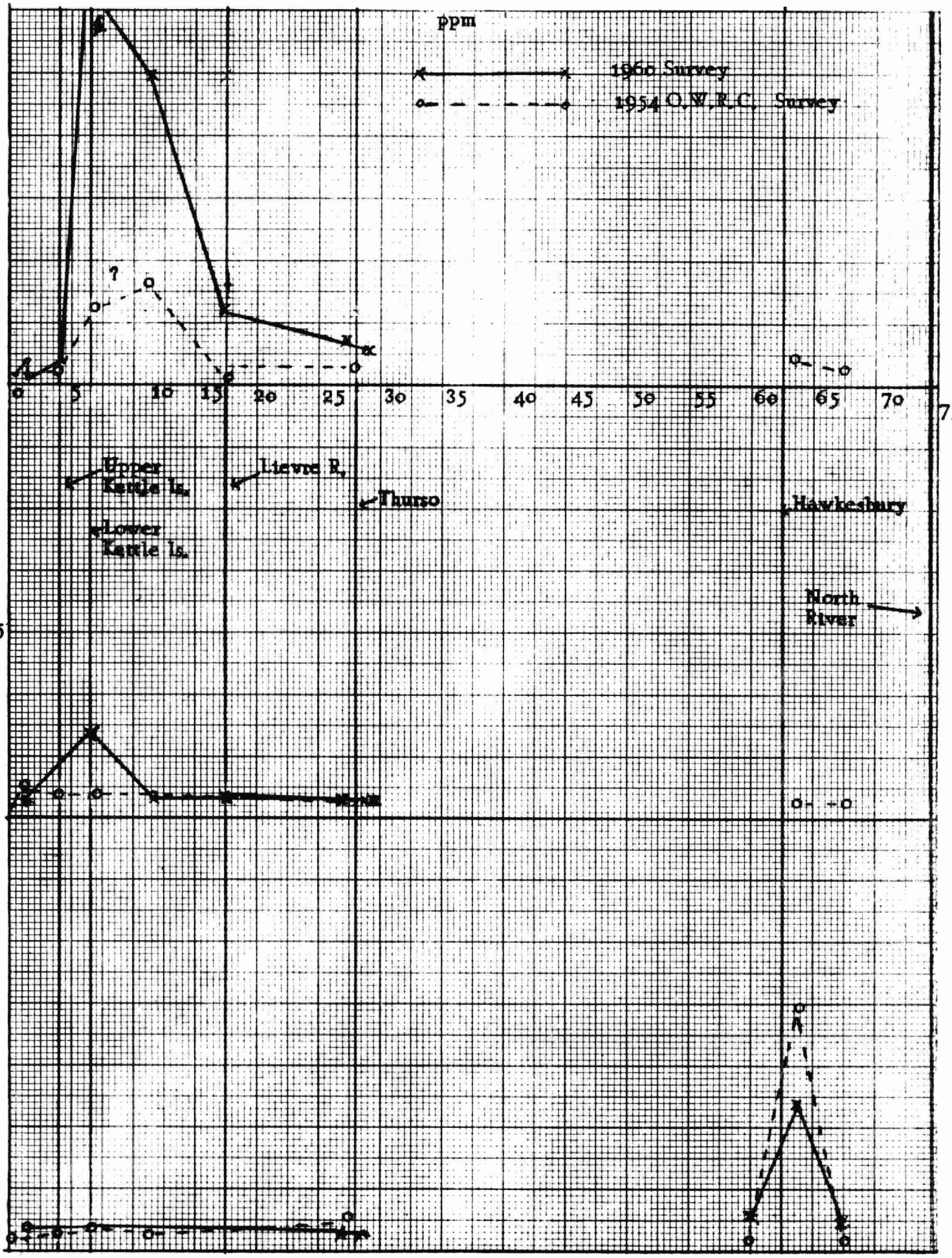

B.O.D.
ppm
1960 Survey
1954 O.W.R.C. Survey
20
15
10
5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Upper Kettle Is.
Lower Kettle Is.
Lievre R.
Thurso
Hawkesbury
North River

FIG 8

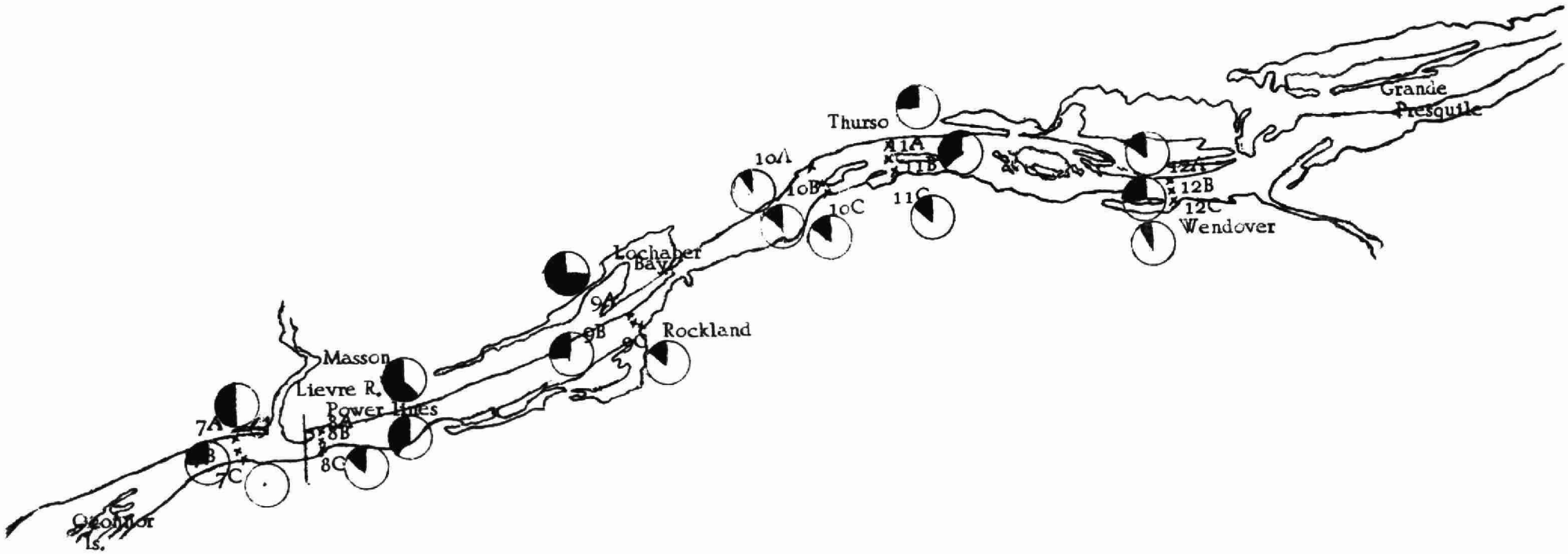


FIGURE 3

Scale 1" - 1 mile.

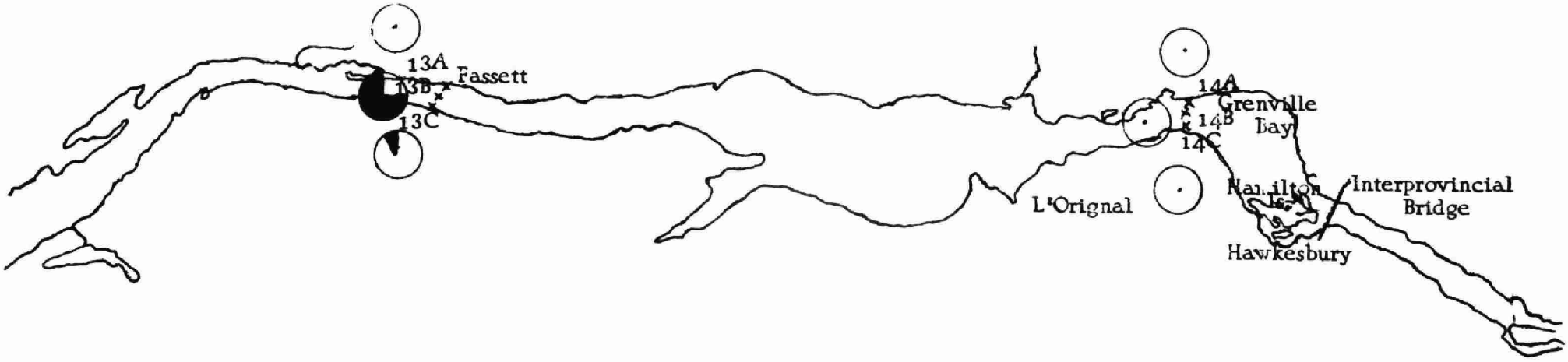


FIGURE 10

Scale 7/8" - 2 miles.

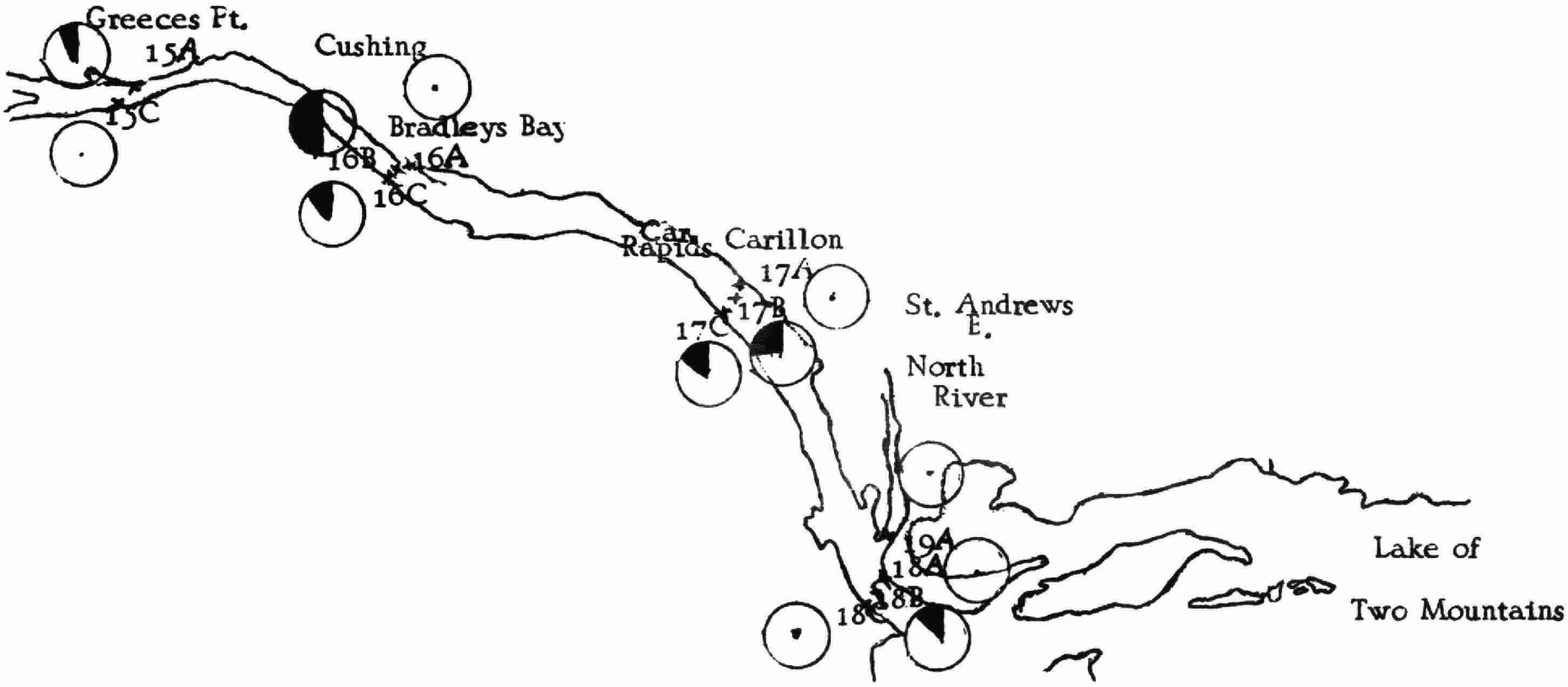


FIGURE 11

Scale 1¼" - 2 miles.



FIGURE 12

Code	Pollution Status
	No evidence of pollution
	Enrichment - ? slight pollution
	Some evidence of pollution
	Advanced recovery stage
	Moderate recovery stage
	Early recovery stage
	Fairly heavy pollution
	Heavy pollution

DISCUSSION

In the discussion which followed Mr. Beak's paper, Dr. Prevost commented on the need for much more biological study of pollution than has been made thus far. He cautioned against interpreting the effects of pollution without detailed study of all forms of aquatic life and indicated that a great deal of research was needed in this field to establish techniques and to fully relate the contributions of the biologist, the biochemist, the engineer, and so on. Although he appreciated Mr. Beak's work, he expressed doubt that this alone would permit one to evaluate pollution.

Dr. Prevost went on to discuss the need for the application of known treatment methods that can be economically installed. He felt that there was perhaps too much emphasis on using the assimilating capacity of a river where treatment could be applied. This resulted in localized pollution, before the effect of dilution was obtained.

Mr. Beak agreed with the need for research in the biological field, and, with the realization that his conclusions are based on only a part of the total biota, he records all his data in appendices to his reports so that future workers can work it over.

Dr. Berry continued the discussion, commenting on the use of bio-assays by the Commission and the International Joint Commission, emphasizing that only by relating all aspects of pollution study is it possible to get a true picture of what is happening in a stream. It was recognized, too, that, in spite of the amount of waste being discharged to the Ottawa River, by the time it joins the St. Lawrence the pollution has been largely spent. Nevertheless, a thorough investigation from all different angles is needed to determine just how much can be safely tolerated, and all available methods of determining the condition of a stream must be used.

Dr. Gallay referred to Mr. Beak's studies by explaining that the Ottawa Valley Effluent Improvement Committee undertook the type of study made by Mr. Beak because it represented a continuing record of effect, rather than the effect of the moment that was measured by analysis of the water.

He went on to comment on the need for a realistic appraisal of waste disposal, in which the assimilating capacities of the large, fast-flowing rivers should be recognized. The location of sampling points, too, was of great importance, as it is always possible to show great reductions in analytical results in very short distances from sewer outfalls. In interpreting analytical results, his company examined data representing conditions at or near an outfall at Hull, and,

while it was first expected that the high BOD was due to industrial waste, the presence of high concentrations of organic nitrogen indicated other than industrial waste (likely sanitary sewage) since nitrogen should be low in pulp mill waste.

Mr. W. C. R. Jones of the E. B. Eddy Company, spoke briefly on the efforts of the industry to improve waste controls, and assured the meeting that all practical means were to be used to recover fibre and other losses, and that the steps which were outlined in the various Effluent Improvement Committee Reports represented only a small part of what the industry as a whole was doing and hoped yet to do.

The discussion continued with reference to the need for expanding the existing knowledge of the relationship between biological and other means of analysis. The presence or absence of certain organisms in itself is of limited value unless it is possible to know the physical or chemical conditions which influence aquatic growth. Mr. Beak suggested that all government agencies, including the Federal Government, have a part to play in the research that should be undertaken.

Dr. Berry concluded the discussion by commenting on the agreement of opinion that had been expressed that control and treatment of wastes was necessary, and that the degree to which wastes should be treated should be related to the resultant effects on the streams.

A REVIEW OF METHODS

OF TREATING PULP AND PAPER MILL EFFLUENTS

OTHER THAN SPENT COOKING LIQUORS

by

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There can be no doubt as to the widespread interest in the problems of water use and waste water disposal in the pulp and paper industry. While there can be some argument about the immediacy of the problem in some areas of Ontario and about the remedial measures necessary in other areas, the fact that all the populated, industrialized areas are, or will be faced with problems of waste disposal and stream pollution cannot be disputed. Some solution of these difficulties will have to be found, if not now, then in the not too distant future.

It is the intention of this paper to review the methods of treating pulp and paper mill effluents used in the regions where these problems have already occurred, that is in various areas of the United States. The subject of the disposal of spent cooking liquors will be ignored as will methods of treatment designed specifically for re-use of the waste water.

In the writer's opinion various methods of treating mill wastes have been developed for the following three related reasons:

1. Insufficient flow in the receiving stream;

2. High population density;

3. High concentration of industry.

In Ontario with its vast areas of lakes and rivers, it is difficult to imagine operating a paper mill without an excess of water; yet this does occur in many part of the United States. For instance, Porter and Bishop (1) describe a waste treatment system, where at extreme low flow the mill effluent makes up 40% of the total stream flow. The normal low flow in this particular stream is 55 c.f.s. This may be compared to the average annual flow in the St.Mary's River at Sault St.Marie of 72,600 c.f.s. Miller and Kniskern (2) discuss the operations of a large integrated mill where at times the water usage is equal to the stream flow. Coogan (3) describes the situation at a large mill where, in the dry season, the flow is literally zero. Many more such instances could be cited.

As regards population density, little can be said that is not already obvious. There are many areas on this continent (several in this country) where large concentrations of population make the operations of a water-using industry such as ours extremely difficult. It has been stated, for instance, that 25,000,000 people live within a 100-mile radius of Philadelphia. Even though this area is crossed by several large rivers and is close to tide water, one cannot conceive of the disposal of water-borne wastes without some degree of treatment.

While a high concentration of industry is usually accompanied by a high population density, this is not necessarily true, particularly in the paper industry. For instance, Wisconsin, a relatively small state, ranks twentieth in population density in the United States and yet leads the country in paper production.

Perhaps, the principal reason for waste treatment has been best expressed by the President of the Institute of Paper Chemistry in these words (4):

> "A stream should contribute its service to as many phases of the surrounding economy as it can, and those who enjoy its services are obliged not to create conditions which will unduly impair the quantity or quality of the water for use by others."

Having established the reasons for the necessity for waste treatment, the methods used by others to solve the problems of waste disposal can be examined. It should not be inferred that any of these methods will necessarily be of use to any mill in this Province. The utility of any system of waste treatment is affected by the nature of the waste, the availability of land, the requirements laid down by government authorities and not least by climatic conditions. However, if the methods are not usable, something may be learned by studying their evolution and application.

As mentioned above, problems of spent pulping liquors will be avoided. The wastes to be considered include paper machine white waters, de-inking wastes, bleach plant wastes and pulp mill wastes which are not normally treated in any present or proposed recovery process. Methods of treatment which involve re-use of water will also not be considered. This is an area in which great progress has been made, and with which most production supervisory personnel are quite familiar.

METHODS OF TREATMENT

Treatment of wastes in the sense of this discussion may be conveniently divided into primary treatment and secondary treatment. Primary treatment as used in the literature seems to include any means of suspended solids removal from mill effluents. Secondary treatment refers to removal of organic material by biological means, that is removal of Biochemical Oxygen Demand.

In the pulp and paper industry, solids removal from effluents is invariably accompanied by some removal of BOD; also, biological removal of BOD is accompanied by a reduction in suspended solids.

PRIMARY TREATMENT

As suggested, primary treatment involves suspended solids removal. This is usually accomplished by some method of reducing the rate of flow of the effluent stream. Chemicals may be added to promote the coagulation of the solids particles and cause a faster rate of settling.

The simplest method of reducing the effluent flow rate is the use of ponds or lagoons. Berger (5) reviews the use of ponds in the southern kraft and newsprint industry. Data given by Berger include the following:

Pond area - 0.02 acres per ton of production (not including sludge disposal area)

Suspended solids removal - 85%

Cost of single pond cleaning - 9 cents per ton of production.

Cost of pond (400 ton bleached kraft mill) $96,000 (two ponds)

Cost of pond cleaning for this mill - 34 cents per ton of production (four cleanings per year)

It can be seen that while the ponds are efficient in terms of solids removal, the area required for settling only could be quite large for some mills.

The use of settling basins at a northern mill has also been reported (6). This mill has two basins with a total area of 2.75 acres handling the wastes from the production of 360 tons of paper. It is reported that all fibre and other suspended material settles out before the effluent overflows to the river.

Similar settling basins have been used in the past at mills in Pennsylvania (7) (8) (9). At one mill (8) (9) there were two basins 400 feet by 60 feet by 7 feet deep and a large lagoon for sludge . At a mill production of 305 tons per day, basin life was 1.6 months and suspended solids removal averaged over 95%. It might also be noted that at this mill alum was used as a coagulant at the rate of 3200 pounds per day.

While settling basins are effective in the removal of suspended solids, and the capital investment involved is relatively low, they do have some marked disadvantages. It is evident that considerable land is required even in the best of circumstances. As the basins fill with solids, the retention time decreaseswith a related decrease in the efficiency of solids removal. Depending on the nature of the settled solids, odour problems can arise because of the anaerobic conditions in the basins.

Consideration of these disadvantages has led to the widespread introduction of solids removal techniques normally used for sewage clarification. These techniques also have serious limitations as Gehm (10) points out. He suggests that these limitations are:

1. Failure of sedimentation devices to perform under rapid changes of temperature, flow and waste characteristics;

2. Failure of such devices to provide an adequate degree of sludge thickening or to produce a relatively uniform degree of thickening;

3. Unsatisfactory devices for removing entrained air from clarifier influents;

4. Where chemical treatment is applied, dissolved organics can render coagulants useless;

5. Use of dispersing agents, colloidal pigments, antifoam agents and some sizing agents upsets coagulation techniques.

In spite of these limitations the techniques are in use. They may be described briefly as settling tanks or clarifiers equipped with sludge collection mechanisms which permit the continuous or intermittent discharge of the settled solids. They have been of particular value in the part of the industry operating de-inking mills where the sewered solids have a high inorganic content. Palladino and Baigas (11) describe installations operating on such wastes in two widely separated parts of the United States. These installations remove more than 90% of the settleable solids as a sludge at over 10% consistency. Palladino (12) has also described several of these installations operating in an area with a large concentration of de-inking mills. In this area suspended solids removals are normally about 75%, with the remaining solids containing less organics than originally. At the time the work was reported (1956), 30,000,000 gallons per day of combined waste waters from de-inking mills were being treated. In all cases the clarifier effluent is discharged directly to the river.

In some installations the addition of chemicals is necessary for the successful coagulation and settling of the suspended solids. The chemicals used are for the most part those normally applied to water treatment such as alum, lime, activated silica and some of the newer synthetic coagulant aids. For instance, at a moulded pulp products mill in California, lime and alum are added to the mill effluent which is then passed through a clarifier (13). A rather unique use of a portion of the clarified effluent is practised, in that it is pumped to the log pond to make up for evaporation which amounts to 300 gallons per minute in the summer months.

At another mill (14) with which the writer is acquainted alum, glue and activated silica have been used to effect coagulation of the colloidal solids. In this case a reduction of over 90% in the suspended solids content was possible when conditions were favourable. However, as noted above, Gehm suggests that dissolved organics can render coagulants useless. At the mill in question, the pulping of unbarked hardwoods is practised. When large quantities of oak are used (containing a high propertion of tannins) clarification of the effluent is virtually impossible even at a chemical cost of close to $500 per day. An obvious solution is to control the use of oak. Clarified effluent from this system passes to a lake through a submerged pipe 1200 feet long, the last 700 feet of which is fitted with distribution nozzles on 20 foot centres.

Most mills practising secondary treatment on mill effluents incorporate some form of suspended solids removal as part of the entire treatment system. These will be dealt with in the following section.

SECONDARY TREATMENT

It has been suggested earlier that secondary treatment involves the removal of organic material from mill effluents by biological means. In other words, the Biochemical Oxygen Demand of the mill effluents is significantly reduced. The biological processes can be either anaerobic or aerobic. In the latter, the micro-organisms involved require free oxygen in order to complete their life cycle, while in the former the oxygen is obtained from the organic molecules consumed. In the pulp and paper industry anaerobic processes have been found to be of little use. The discussion will therefore be confined to the aerobic processes. In order of increasing mechanical complexity these are stabilization ponds or lagoons, trickling filters and activated sludge plants.

Stabilization Ponds

From the viewpoints of construction and capital investment involved stabilization ponds constitute the best form of BOD removal. However, as with settling basins, relatively large land areas are involved. Berger (15) and Blosser (16) discuss some of the requirements and the efficiencies of such ponds. Both authors note the desirability of shallow ponds in order to maintain the aerobic conditions. Blosser also states that the rate of aeration is the main factor in BOD removal, aeration being achieved by pumping over riffles, by diffusing nozzles or by flowage through a series of lagoons and over natural terrain. Berger reports that BOD loadings as high as 130 pounds per acre per day have been reduced 80% in 20 days.

Since stabilization ponds lend themselves to some extent to warmer climates, they have found their greatest use in the southern kraft industry. Porter and Bishop (1) describe an installation at a mill in Texas. As originally set up this mill had two ponds with a capacity of 250 acre-feet giving a retention time of 13 days at an effluent flow of 8,000,000 gallons per day. BOD reduction was 80-85% in the summer and 55% in the winter. Later a third pond was added for primary settling of the suspended solids. The distance from the mill to the river is two miles and the difference in height is 145 feet. A recent report (17) indicates that this system has been replaced by two activated sludge plants.

A similar system was installed at a mill in Georgia several years ago (18). At this mill the distance to the river is 7.5 miles and the difference in height is 100 feet. Total area of the pond system is close to 450 acres, effluent flow is 6,000,000 gallons per day. Retention time is over 80 days. Cost of the system was $450,000. The system was designed so that the dissolved oxygen in the river would never fall below 2.5 p.p.m. BOD figures through the system are interesting and are reported to be as follows:

Strong waste into storage pond	- 500	p.p.m.
Strong waste out of storage pond	- 300	p.p.m.
Weak waste from mill	- 250	p.p.m.
Combined waste in settling pond	- 200	p.p.m.
Combined waste out of settling pond	- 175	p.p.m.
Combined waste out of first oxidation pond	- 115	p.p.m.
Combined waste out of second oxidation pond	- 50	p.p.m.
Combined waste out of Stoke's pond	- 36	p.p.m.
Combined waste out of Carroll's pond	- 13	p.p.m.
Combined waste in Jumping Gully Creek 500 feet above river	- 30	p.p.m.
River water above outfall	- 0.6	p.p.m.
River water below outfall	- 0.3 - 1.1	p.p.m.

A more recent installation at another kraft mill in the same State has also been described (19). At this mill total pond area is about 750 acres with a drop in height of 29 feet. The system is preceded by a 150 foot diameter clarifier for removal of suspended solids. The flow from the clarifier to

the ponds is 12,000,000 gallons per day. At the time the report on the system was given very few operating results were available. It may be noted, however, that the system was chosen as offering the best possibilities for subsequent modification if this were found necessary.

Ratliff (20) describes a system in use at a board mill using waste paper. Due to adverse conditions in the receiving stream, the various methods of BOD reduction were considered. Trickling filters and activated sludge were both found to be unsatisfactory. The system finally chosen consists of two settling basins which are used alternately. Effluent from these flows to a lagoon with an area of 160,000 square feet. This lagoon is divided by a centre dike with a gap at one end. The effluent is circulated by being pumped and allowed to cascade over the closed end of the dike. The circulation rate is 16 times the normal mill flow. With a retention time of 11.3 days BOD reductions of 50-60% were obtained. At the time the details of this system were given, a trickling filter was being installed to treat the lagoon effluent.

Crawford (21) mentions a stabilization pond system which was improved by diversion of strong wastes to a separate pond. The diverted wastes contained 30% of the pollution load in 3% of the total effluent volume. In the original system the BOD reductions had averaged 65%. Reduction of the BOD of the strong wastes in the new system is close to 85%. Retention time in the new pond is 60 days.

As Blosser (16) points out most of the stabilization ponds in use actually reduce the BOD by a combination of both the anaerobic and aerobic processes. Krancher (22) describes a system of lagoons 147 acres in extent in which the action is to a large degree anaerobic. These lagoons, in one form or another, have been in use for close to 60 years. Since the lagoons are used partially for storage and controlled release of effluent depending on stream flow, retention time and BOD reduction both vary - the latter between 25% and 75%. The effluent release is controlled to permit a dilution of 1 to 350 in the river and a colour increase of 20 in the river water.

Large holding lagoons are used in some locations to permit uniform effluent release to the river. Berger (15) gives an example of such a lagoon 140 acres in area by 10 feet deep. Retention time in this lagoon is 15 days and BOD removals average 39%. Coogan (3) has also described a holding lagoon system where the total mill effluent must be withheld from the river at certain times during the year.

Trickling Filters

Generally, trickling filters have proven to be unsatisfactory when applied to pulp and paper mill wastes. The size of the installation required has been one adverse factor; for instance, Berger (23) estimates that a 100 ton strawboard mill would require three acres of filters 6 feet deep.

In spite of this adverse picture, proposed installations of trickling filters have been reported, the filters usually being preceded by some effective means of suspended solids removal. The addition of a trickling filter to an existing stabilization pond system has already been mentioned (20). Ackerman (7) describes a proposed installation at a small specialty mill. Strong and weak wastes are mixed in a lagoon of 1,000,000 gallons capacity with a retention time of 18 hours. From the lagoon the effluent goes to the trickling filter and thence to a secondary lagoon. Provision is made for recirculation of the secondary effluent. BOD loadings on the trickling filter are about 2.5 pounds per cubic yard. Both the primary and secondary lagoons are duplicated so that only one of each is in use at any one time. The trickling filter is added to an existing system and the estimated cost is $60,000. Costs of pumping and nutrients are expected to be $20- $25 per day.

Recent developments of plastic trickling filter media may increase the utility of this method in the treatment of mill wastes. Egan and Sandlin (24) describe the pilot plant evaluation of such media. Two facts emerged from this study. First the authors found that the BOD loadings could be substantially increased by operating in the thermophilic range. Secondly, because of failures of the commercially available media a new media was designed with twice the surface area of the best available. The installation of a full-scale waste treatment plant using this new material has recently been reported (25).

Activated Sludge

The past ten years have seen increasing interest in the applications of the activated sludge process to the treatment of mill effluents. Almost all mill wastes are deficient in the nitrogen and phosphorous necessary for biological growth and these must be added before the process can be successful. Various installations in the pulp and paper industry are briefly reviewed by Sullins (17).

The application of the activated sludge process to de-inking mill effluent has been reported in detail from the pilot plant to a full-scale installation by Palladino (26, 27, 12) and Blosser (28). Palladino (26) reports that BOD removals in the pilot plant averaged 68%. From the data accumulated, a demonstration plant to treat 0.5 million gallons per day was designed and built. In this plant BOD removals were close to 90%.

Operation of this demonstration plant was followed by the construction of a plant using commercially available equipment and also designed to treat 0.5 million gallons per day (28). BOD removals at this installation at loadings of 94 pounds of BOD per 1000 cubic feet per day have been in excess of 90%. Excess secondary sludge is disposed of in sludge drying beds along with thr primary sludge.

A similar description in detail of the process applied to kraft, semi-chemical bleaching and paper mill effluents has also been published (2, 29, 30, 31). This plant built at a cost of $2,000,000 handles over 20,000,000 gallons per day from the production of 1000 tons of various board products. Flow through the plant includes all wastes from the wood yard to midway through the bleaching process, plus excess white water from the semi - chemical paper machines and high alkalinity fly ash from two bark-burning boilers. Treatment efficiencies in early 1960 approached 85% suspended solids removal and 90% BOD removal. It is stated that every ton of board carries a pollution abatement cost of about $1.25. Pearman and Burns (30) report that after the first year of operation, study of sensitive bottom organisms showed a recovery of 15 miles of river. A major modification to the plant after start-up was the addition of a second clarifier. This permits primary treatment of the bleach plant wastes, the suspended solids in which had interfered with the biological process.

More recently this same company has been instrumental in the installation of a 21,000,000 gallon per day activated sludge plant which treats not only pulp mill wastes but also the sanitary wastes from 3 neighbouring towns (32, 33). While the municipal sewage constitutes less than 5% of the total flow it does provide the necessary nutrients for biological action.

Another recent installation treating 10,000,000 gallons per day and also costing $2,000,000 has been reported (34). This installation is distinguished by the use of turbine surface type aeration.

Spray Irrigation and Land Application

While land application of mill effluents perhaps does not constitute BOD reduction in the sense already discussed, it does keep oxygen consuming materials out of the receiving stream.

The procedures used are reviewed by Gellman and Blosser (35). It is noted that there are two distinct methods, one involving actual irrigation of cover crops and the other involving filtration of the effluent into the soil with no consideration for plant growth. The median land requirement of the installations reviewed is 1 to 1.5 acres per ton of daily pulp capacity. The necessity of having storage ponds

for the removal of nozzle-plugging material is noted. It is stated that strong pulping wastes when suitably diluted do not destroy vegetation. The authors recommend consultation with local agricultural and geological experts before embarking on any irrigation program.

Meighen (36) discusses the experimental spray irrigation of strawboard wastes. Irrigation at a rate equivalent to 0.25 inches of precipitation per day appeared to be practical. Meighen states that a good cover crop is desirable. The experimental spraying of effluent from a paperboard mill using waste paper and purchased pulp has also been reported (37). The effluent contained 240 p.p.m. suspended solids and 200 to 400 p.p.m. BOD. It was successfully sprayed at a rate of 0.28 inches per day. Alfalfa and field corn thrived on the treatment. It is interesting that no coating of fibre on either the plants or the ground was noted.

Crawford (21) describes this method of treatment applied to certain kraft pulp mill wastes. These include evaporator condensate, digester condensate and dregs washings. They are reported to be ideal for spray irrigation because of extremely low solids. Prior to spraying they are lagooned for 60 days. Spray rate is 1,000,000 gallons per ten acres per eight hours, equivalent to 0.45 inches per acre per hour. Improvements in corn and peanut crops have been noted. Fifty acres of woodlands have been sprayed with no apparent damage. Costs were $25,000 for 100 acres of land and $48,500 for the spray system.

Sludge Disposal

All the treatment methods described have one problem in common - the disposal of the separated solids or sludge. The magnitude of this problem can be seen by looking at some of the data provided by Laws and Burns (31) in their description of the activated sludge plant at Covington, Virginia. At this mill it is necessary to dispose of 75,400 pounds of sludge solids per day, the sludge flow being 650,000 gallons. Palladino (12) reports that in the Kalamazoo River Valley the treatment of 50,000,000 gallons per day of effluent results in the production of 1,000,000 gallons per day of sludge at 10% solids.

The problem of disposal of these sludges is accentuated by the fact that many of them are difficult to thicken on conventional equipment (10). Gehm (38) points out that a tremendous reduction in volume can be obtained by even moderate thickening. He notes that the underflow from a clarifier operating on white water might be around 1.75% solids. If the original white water contained two pounds of solids per 1000 gallons, the sludge from 1,000,000 gallons would occupy 1820 cubic feet. If this could be thickened to 20% solids the volume would be only 158 cubic feet.

For the most part sludges are thickened as far as possible and conveyed to dumps. Successful methods of thickening used have been either vacuum filters or drying beds. Some experimental work has been carried out on the use of conveyor centrifuges and pressure filters (38, 39). Disposal of thickened sludge by incineration has also been tested on a laboratory scale (40). However, land-fill methods of one kind or another still hold their place as the most important ways of disposal.

CONCLUSION

It is obvious that various methods of waste disposal used in conventional sewage treatment can be applied to the disposal of pulp and paper mill wastes. However, most of the writers in the field stress the need for evaluation of each situation on its own merits.

Perhaps McKinney's (41) summary of the applicability of biological treatment to industrial wastes could be repeated and applied to the entire waste treatment scheme:

"The selection of a particular biological treatment system for a specific industrial waste cannot be made without a full consideration of such factors as:

1. Degree of treatment required;
2. Nature of organic wastes;
3. Concentration of organic wastes;
4. Volume of wastes;
5. Variation in waste flow;
6. Space available;
7. Capital costs;
8. Operating costs."

These factors plus that of sludge disposal and in this country climatic variation should certainly be considered in any study of any type of waste treatment system.

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DISCUSSION

In the discussion which followed, the possibility of reducing waste treatment costs if the industrial waste were mixed with domestic sewage and both treated together was discussed. It was suggested the only direct cost which would be reduced would be the cost of nutrients, but if it were not possible to assess municipalities for some volume of their wastes, this would prove a problem. Reference was made to a plant in Virginia which treated all wastes from three municipalities. The company assumed all the operating costs of the plant and all the depreciation charges. The municipalities, between them, paid slightly less than five per cent of the capital cost of the plant. Their waste flow was approximately five per cent of the total waste flow. Total cost of the plant was $4½/ millions.

In assessing the operating cost of one plant referred to in Dr. McFarlane's paper, it was stated that it included depreciation, labor maintenance, repairs and pollution abatement measures in the mill such as waste monitoring and depreciation on equipment. This was approximately 50 per cent of the operating cost. The nutrients were less than 10 per cent, labor and maintenance would make up over 20 per cent.

FACILITIES OF THE ONTARIO WATER RESOURCES COMMISSION FOR JOINT RESEARCH WITH THE PULP AND PAPER INDUSTRY

by

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Facilities of the Ontario Water Resources Commission for joint research with The Pulp and Paper Industry

by

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The need for adequate research programs will be thoroughly apparent to all in the pulp and paper industry. This has long been the practice in the development of new products and in improving processes. Everywhere in our daily lives we see the results of research carried out by many persons and organizations. Greater emphasis on research is now the trend. The pattern is clear and knowledge is essential if we are to succeed in any worthwhile project. The more difficult the problem, the greater is the need for research.

THE NEED FOR RESEARCH IN WASTE DISPOSAL

In the treatment and disposal of wastes from the paper industry we are confronted with a difficult problem. It involves large volumes and a variety of constituents which may have adverse effects on the receiving water course. Acceptable and economical methods have not been developed as yet for all these wastes. The measures needed are usually quite different than those for treating domestic sewage or most industrial wastes. In the 41 mills in Ontario it is estimated that the daily waste discharges exceed 400 million gallons, and that they contain among other ingredients a total of 1,115,000 lbs of Biochemical oxygen demand.

Some thoughts of this Commission in respect to research programs may be appropriate at this time. Water pollution is constantly changing with the introduction of new products, new processes and more industries. Many of these wastes are chemical in nature, and even in high dilutions can travel long distances in water before breaking down. Under these circumstances it is felt there is now a greater need for research than at any previous time. This must be a search for the truth upon which essential decisions can be made. How much do we know of the things which surround us and which affect our well-being? In many instances that knowledge can only be regarded as superficial. Conditions are changing rapidly in this ever-changing world. It has been said that true wisdom

is not achieved in a mere knowledge of facts, for the things we generally refer to as facts have a habit of altering with every change in the light. It is rather to be found in the sharpening of the tools of logic; in eternally searching, challenging, testing, accepting, rejecting and modifying - in a constant and courageous search for the truth. This need for research has been clearly recognized by the Water Resources Commission in the over-all program it has adopted and in the provision made for such activities.

WHAT IS NEEDED IN RESEARCH

It does appear that what is needed in any research program as a first requirement is a clear objective. This must be directed to the problems of the time, and those which may be reasonably foreseen. It may be necessary to undertake basic research to learn something new about natural phenomena, or to direct our efforts to applied research for the purpose of applying findings for present or future needs. Research activities in this field can cover a wide range. These measures may take place in the laboratory, in the treatment plant, in the field, or wherever observations can aid in improving existing practices or in developing new ones.

Research programs need clear direction. Much money and effort will be required. The objective in each instance should be clearly defined. All of this can best be done by the joint efforts of all concerned in the work. Changing conditions, particularly in industry, call for a continuous review and adjustment of our approaches to these problems. This will necessitate close co-ordination of all groups and including many kinds of training and experience.

These observations, in brief contain some of the philosophy of the Commission towards research programs. The need is particularly applicable to the pulp and paper industry where waste disposal has always proven to be a difficult one. The Commission welcomes the opportunity to join forces with the industry in a joint approach to the problems of the day. It is recognized that much has already been done, and that many groups and agencies are at work. It is also clear that the more efforts that can be made in an intelligent direction the sooner will the answer be found. As has been said, research is a constant and courageous search for the truth. Here is a field which offers all the challenges that even the most eager may wish.

KINDS OF RESEARCH

As we set out on this research program we need to visualize the kinds of studies that will be most productive to our common objective of clean streams. The Commission,

because of its familiarity with waste disposal in general, will be interested in the treatment of these wastes as well as means for preventing their escape to the streams. It will not be involved in studying new industrial processes even though these may be successful in reducing the volume of waste or in changing its nature. It is believed that aspect can best be left entirely to the industry. The Commission will also study closely the effects of any waste on the receiving waters, how far it will travel, what natural agencies will break it down, what effect it will have on water use, on fish, on wildlife, animals and humans. Continuous supervision of these aspects will constitute a major program for which the Commission's staff is equipped to act either jointly or singly.

FACILITIES AVAILABLE

It can be assumed that any successful research program must be a joint one in which each party will utilize the facilities available to him. Accordingly it is proposed to review here some of the ways in which the OWRC can act in this team work.

(a) This laboratory building has many attractive features for research work. It was designed with this in mind. The laboratory facilities are most modern, and the building is well provided with testing equipment. There is also a substantial amount of space available in which research work can be carried on. The construction of this building, so long desired, has given impetus to a program of research which the Commission feels is essential in both water and sewage works.

(b) Equipment which can be employed to advantage in planning research is essential, and much of it has been provided with this building. The large test floor can accommodate pilot plants or devices requiring space and facilities to go with it. In dealing with industrial wastes these facilities are desirable. It is hoped that much can be done with pilot plants. A connection was provided with a trunk sewer of metro Toronto which passes the building in the ravine. Sewage can be pumped from this as required for experimental works, or water may be drawn from the Humber River through another pipe line.

(c) Valuable as buildings and equipment may be the greatest asset must be considered as the staff available for research. The Commission feels fortunate in this personnel and the training they possess. Not only are the staff selected because of their technical backgrounds but they are given opportunities to increase their specialized training. The staff includes persons

trained in sanitary engineering, chemical engineering, chemistry, biology, bacteriology, and in pretty much all subjects related to water, sewage and industrial wastes. Because of this it is possible to conduct research and examinations in all these fields. Bio-assays on industrial wastes and streams are an example of the application of modern technology to a measurement of effects created in the stream. Other modern facilities are available to take full advantage of the needs of research.

The organization into six divisions of the work of the Commission is intended to cover various fields of endeavour. These are sanitary engineering, construction, plant operations, laboratories, research, and water resources. These separate units are co-ordinated to function as one organization, but the qualifications of the personnel cover a truly wide field.

(d) Library facilities are an important tool in a research organization. These have been provided in this building and are under a trained librarian. Contact in this way can be maintained with published material. The Commission is making these library facilities available to all who are engaged in this and in related fields. This will mean an exchange of information from published sources as well as a closer relationship with others.

(e) Apart from the material facilities the Commission feels that one of its most important features consists of the proposal to co-ordinate its efforts with others. There is obviously great need for this rather than following isolated efforts. This close co-ordination with the work of the research laboratories of the pulp and paper industry should be most helpful. Similarly there are many other scientific groups in this country and elsewhere with whom contacts can be most valuable. In the United States great stimulus is being given to research in the sanitary field. In Great Britain most encouraging efforts are to be noted. The National Research Council at Ottawa, the Research Foundation for Ontario, and other similar organizations are always willing to co-operate. Universities offer another fertile field for assistance, and if all are co-ordinated into a well directed program the best results can be expected. Thus the proposal of the Commission to co-ordinate and co-operate with others can be one of the most potent of facilities.

(f) In the organization of the OWRC a separate division of Research has been created. A Director has not yet been selected, but it is hoped this division will soon be on a sound basis with staff and facilities to proceed on this work. This will accentuate the

research activities of the Commission and enable these projects to proceed at a high rate. It is appreciated that research funds must be secured before effective results can be expected. More than one source is expected to be available.

SUMMARY

To summarize the position of the OWRC in relation to research programs it can be empahsized that this is recognized as one of its important activities, with a separate Division assigned to this work, and with plans going forward the results look encouraging for the future. In all of this full support will be given to co-ordination of our efforts with others and the closest co-operation with research workers. The details of how this can best be accomplished with the pulp and paper industry should be reviewed at the earliest date.

DISCUSSION

Following Dr. Berry's presentation the general discussion revealed all in favor of the closest liaison between the industry and the Commission, not only in research but in all parts of an overall program. The form of such liaison was considered, with discussion continuing following a break during which members of the industry's policy group met in private to discuss the situation.

An industry spokesman indicated the industry should be represented in any such liaison by the Technical Section of the Canadian Pulp and Paper Association. A chemical engineering committee was part of the Technical Section and had handled the matter of wastes for many years.

A Commission spokesman suggested the OWRC should appoint a group of its own to work with the industry's Technical Section now that the industry had indicated which organization should represent it in any contacts with the Commission.

In answer to a question concerning the Association's facilities and equipment, a spokesman for the industry said the Technical Section was a service section of the Canadian Pulp and Paper Association, which was included in a technical organization of every pulp and paper producing country in the world except Russia. There were four to six meetings a year to consider problems of the industry. As far as research was concerned, there was a Pulp and Paper Research Institute of Canada, financed by the industry. Also, most or practically all of the companies in Canada had their own research departments. He suggested that once liaison got outside the realm of research, it became a problem of liaison between the Commission and the individual companies.

Another spokesman for the industry indicated, in reply to a suggestion that the research carried on by the Institute did not concern water pollution problems, said that a fair proportion of the work of the Association over a period of years dealt with the reduction of the pollution load.

Waste disposal problems of the industry were discussed and that to solve some would require a completely different kind of production process. A Commission spokesman revealed the OWRC had taken a definite stand in regard to new plants. This policy required companies, prior to completion of new plants, to consult with the Commission in regard to proposed waste treatment procedures. An industry spokesman agreed with such a policy.

POST-CONFERENCE STATEMENT

In a public statement following the meeting, the Ontario Water Resources Commission announced that the technical section of the Canadian Pulp and Paper Association and the Ontario Water Resources Commission would set up a liaison working committee to further the efforts of both organizations in the matter of controlling pollution of Ontario's streams by the industry's wastes. This committee would pursue an active program which would include close contact by the OWRC with all mills in the Province.